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STREAM POLLUTION AND PRESENT STATUS OF CONTROLLING LEGISLATION IN CALIFORNIA.

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INTRODUCTION.

Area and Extent of State. The state of California has a gross area (exclusive of that portion of the shore of the Pacific Ocean over which jurisdiction is exercised) of about 158,300 square miles. The net land surface is approximately 155,650 square miles. In area the state is the second largest in the United States, ranking next to Texas, which, however, has a land area nearly 70 per cent. in excess of that of California. The land area of California is somewhat in excess of the combined areas of the six New England States together with New York and Pennsylvania.

The state is somewhat irregular in shape and its dimensions are not readily expressed. It has a general length of about 780 miles and a maximum length, in air-line measurement from the northwest to the southeast corners, of fully 860 miles. The shore line is stated to be more than 1,000 miles in length. The maximum width of the state is about 260 miles, the minimum width about 140 miles and the general or average width in the neighborhood of 200 miles.

In latitude the state extends from about 32° 30′ north to 42° 0′ north. Points representing equivalent positions on the Atlantic seaboard are respectively located about twenty miles south of Charleston, S. C., and about thirty miles south of Boston, Mass.

Population. The total population of the state in 1910 was about 2,377,500 persons, and the average density per square mile of land area was only 15.3. In respect to total population, California ranked as twelfth among the forty-eight states. In respect to average density of population this state ranked as thirty-fifth, having only about 3 per cent. of that in Rhode Island, 3.7 per cent. of that in Massachusetts and 4.5 per cent. of that

in New Jersey, these three states being, in the order given, by very far the most densely populated states in the United States.

There were eight cities in California, according to the census of 1910, which had a population of at least 25,000. The aggregate population of these cities was about 1,070,000, equivalent to about 45 per cent. of the entire population of the state. In 1910 the population immediately adjacent to San Francisco Bay was about 750,000 and that in and adjacent to Los Angeles fully 500,000, making a total of about 1,250,000 people, or more than 53 per cent. of the state, within these two relatively small areas of comparatively dense population.

From practically the entire population adjacent to San Francisco Bay, the sewage is being or is proposed to be discharged into the waters of the bay whose tidal prism is very large. A large proportion of the population in Los Angeles and vicinity do now or will eventually dispose of sewage more or less directly into the Pacific Ocean. It is estimated that in 1910 fully 1,210,000 people, or 52 per cent. of the total population of the state, were either delivering sewage into the Pacific Ocean directly or into San Francisco Bay, or else were living in communities which will so dispose of sewage. This estimate is only approximate, but is probably sufficiently close to serve present purposes.

At this date there are 231 incorporated cities and towns and at least three sanitary districts in the state. In 1910, San Francisco, the largest city, had a population of about 417,000 people and Los Angeles, the second city, a population of about 319,000. Oakland, with a population in 1910 of about 150,000 inhabitants, is the only other city in the state having a population greater than 100,000. In 1910 there were five cities having populations between 25,000 and 50,000, thirteen between 10,000 and 25,000, ten between 5,000 and 10,000, thirty-four between 2,500 and 5,000 and sixty having less than 2,500 inhabitants. The aggregate population of the 125 cities so represented was about 1,539,000, or about 64.7 per cent. of the total population of the state.

River Systems. There are sixteen principal river systems in the state with independent outlets into the ocean, bays or inland basins. In addition there are very many smaller streams, both tributary to these river systems and with independent outfalls. The largest river system is that of the Sacramento River, which embraces in its drainage basin approximately 2,200 square miles in the state of Oregon and about 24,900 square miles in California, a total of 27,100 square miles. This area is comparable in size with that of the drainage basin of the Susquehanna River, which is about 27,400 square miles in extent and which is the largest river system discharging into the Atlantic Ocean between the Gulf of St. Lawrence on the north and the Gulf of Mexico on the south. The second largest river system in California is the San Joaquin which, without the streams deliver-

ing into Tulare Lake Basin (under existing conditions a practically independent inland basin without an outlet), embraces a total drainage area of 18,300 square miles; with these southerly streams a total area of 30,900 square miles is embraced.

Topography. The State of California is extremely diversified and is mountainous throughout. It is traversed, "in a general northwest-southeast direction, by two distinct and approximately parallel ranges of mountains, which extend almost the entire length of the state. Near the eastern border is the Sierra Nevada; not far from the shore line on the west is the coast range. These two ranges merge into each other about forty miles south of the California-Oregon boundary line, the meeting point being Mount Shasta, which has an elevation of 14,380 feet. They are merged again south of Bakersfield by a cross range known as Tehachapi Mountains."*

Practically all of the great valleys of the state are surrounded by mountain ranges, none of which have peaks less than 3,000 or 4,000 feet in height, while some have peaks rising to elevations as great as from 8,000 to 14,500 feet. In the more arid sections of the state the water courses are naturally at considerable distances apart and in these sections cities have developed in locations remote from any body of water, flowing or quiet. The mountain ranges in the state are controlling factors in rainfall, both as respects distribution and total annual depth.

Climate. The climate of California may be roughly described as wet and dry, the seasons being really two in number, namely a wet season, generally embracing the months from October to March, and a dry season, extending from April to September, inclusive. Of course, there are exceptions to this statement, rain falling in the higher mountains practically throughout the year while but small rainfall occurs on the arid plains and that during a very short interval only in the year. Generally speaking, the rainfall in the northerly portion of the state is much heavier than that in the southerly.

The long dry seasons have a decided effect upon stream flow and many streams in the state, especially in the southern portion, are intermittent in character. These streams would naturally, of course, produce extremely difficult problems in the matter of sewage disposal by dilution.

Throughout the state, except at the higher altitudes (4,000 feet and over), the climate is mild, winter temperatures seldom being maintained for continued intervals much below the freezing point. The climate is, therefore, particularly favorable to all biological processes of sewage treatment and disposal. Indeed, in certain types of sewage pre-treatment devices, difficulties are sometimes encountered due to excessive biological activity. On account of the dryness of the climate in many portions of the state,

* Trans. Am. Soc. C. E. Vol. LXI, Dec., 1908, p. 283.

sewage disposal by irrigation, either with or without pre-treatment, according to conditions, is a frequent, popular and oftentimes satisfactory procedure.

Sewerage and Sewage Disposal in California.

Sewer Systems. Data with respect to the sewerage and the treatment of the sewage of municipalities, institutions, industrial establishments, resorts, etc., are meager and have never been officially compiled by any authority with competent jurisdiction. The data submitted herewith, therefore, must be considered as tentative and provisional, subject to considerable revision. The statistics presented are mainly those gathered in various ways by the writer acting as consulting engineer for the State Board of Health. At this date a painstaking canvass of the sewerage and sewage treatment situation with respect to incorporated communities is in progress and the data applying thereto will be available in the near future.

From the information at hand it appears that among the 231 incorporated places and three incorporated sanitary districts there are 160 communities with more or less complete public sewerage systems, ten communities with private sewers serving a considerable portion of the population and sixty-four places in which no systems have yet been introduced. There are at least five unincorporated places having public sewerage systems.

The total populations represented in the several classes of communities above noted was, in 1910, about as follows: incorporated communities (including sanitary districts) having public sewerage systems, 1,580,700; incorporated places having private sewers, 10,200; incorporated communities having no sewers, 72,400; unincorporated places having public sewers, 5,100. The population of all communities now known to have more or less complete sewerage systems was, in 1910, about 1,596,000 or 96 per cent. of the total population of incorporated communities and sanitary districts and 67 per cent. of the total population of the state.

Sewage Disposal. The incorporated communities of the state represented as having sewerage systems, public or private, may be classified, according to the current methods of sewage treatment and disposal, as follows:

TABLE No. 1.

Summarized Statistics Relating to the Sewerage and Sewage Disposal of Incorporated Cities and Towns and Sanitary Districts in California—October, 1913.

Sewerage Systems:	Number	Pop. 1910
Municipalities—		
Having public sewerage systems	157	1,577,100
Having private sewerage systems	10	10,200
Without sewerage systems	64	72,400
Sanitary Districts—		
Having public sewerage systems	3	3,600
	234	1,663,300

Sewage Treatment and Disposal:		
Disposal of raw or untreated Sewage—		
Into inland fresh-water streams, lakes, etc.	27	117,100
Into tidal bays, estuaries, etc.	37	787,100
Into ocean at coast	9	347,500
Through pre-treatment processes	89	284,600
Through final treatment processes directly	9	58,600
No information	1	2,300
	172	1,597,200
Duplicates	2	6,300
	170	1,590,900
Disposal of Pre-treated Sewage—		
Into inland fresh-water streams, lakes, etc.	32	76,100
Into tidal bays, estuaries, etc.	2	3,100
Into ocean at coast	9	55,000
Through final treatment processes	40	143,200
No information	6	7,200
	89	284,600
Nature of Preparatory Treatment—		
Through septic tanks	79	224,000
Through Imhoff tanks	6	13,800
Through septic tanks and Imhoff tanks	1	30,300
Through settling tanks	2	8,700
Miscellaneous	1	7,800
	89	284,600
Nature of Final Treatment (supposedly stable effluents)—		
Sewer farms and irrigated lands	46	195,400
Contact beds	3	4,700
Intermittent sand filters	2	3,900
Sub-Surface irrigation	1	1,000
Chemical disinfection	1	2,500
	53	207,500
Duplicates	4	5,700
	49	201,800
Sewer Farms and Irrigated Lands—		
Disposal on publicly owned lands	29	115,700
Disposal on privately owned lands	9	40,500
Disposal on both publicly and privately owned lands	3	32,300
No information	5	6,900
	46	195,400

From the table it will be observed that the population in incorporated communities disposing of raw sewage in bodies of water, either fresh or salt, is approximately 1,251,700, or about 78 per cent. of the total popu-

lation in communities having public or private sewerage systems. Only about 117,100 persons, however, live in communities which discharge crude sewage into inland waters. The population in communities having preparatory sewage treatment is about 284,600, while that in communities which have some final method of treatment, as indicated, is about 201,800.

Stream Pollution in California.

Pollution of Surface Waters by Community Sewages. The majority (46 out of 68) of the communities having sewerage systems and situated upon the inland waters of the state have installed sewage treatment plants. Ten of these places utilize sewer farms, one has intermittent sand filters, one has contact beds and one has chemical disinfection of a septic tank effluent. Forty-six places in California are disposing of all or a major portion of their sewage by the irrigation of publicly and privately owned lands. Thirty-six of these places are not located on inland water courses. The two largest cities in the state on such waters, namely Sacramento and Stockton, have not yet undertaken sewage treatment but plans for doing so are now under way in both cases and reasonably effective treatment will probably be given within a short time.

There is no stream of consequence in the state of California which may be said to be grossly polluted with sewage. No river of any consequence receives at any point, so far as is known to the writer, a quantity of sewage sufficient to produce a real nuisance. There is a number of cases of small communities on very small streams where sewage or sewage effluents are discharged in a way which may produce nuisances of a local character only, during a portion of the year. Considering the state as a whole, it may be said that the æsthetic and sanitary condition of streams is at present fairly satisfactory. Nevertheless, with the program which is proposed by the State Board of Health for the control of the purity of inland waters under newly enacted legislation, it would appear to be perfectly safe to assume that conditions will be improved rather than otherwise. In this connection it should be remembered that, at the present time, the population in the state is relatively very sparse and that the extended areas of comparatively dense population are tributary to salt and not to fresh water.

It is hoped that as the state develops in population and the tendency toward stream contamination would naturally become greater, the machinery for safeguarding the purity of all waters, both inland and salt, will have become so thoroughly developed and so effective that satisfactory conditions will continue for all time.

Pollution of Surface Waters by Trade Wastes. California is not as yet a state of great industrial developments. The number of manufactures and industries represented is still comparatively small. Aside from the industries named below most of those which have been established in the

state are in communities tributary to large bodies of salt water and not upon small inland streams. The greater industries of the state which at all affect the quality of surface waters are lumbering, mining, canning, tanning, paper making, beet sugar manufacture and oil refining. Certain of our mountain streams have been injuriously affected by sawmill refuse, principally sawdust. This evil may ordinarily be corrected in simple and effective fashion and such remedies will be applied through the joint efforts of the California Fish and Game Commission and the State Board of Health. Certain California streams have been affected by mining in two ways: (a) by débris from hydraulic or placer mining and (b) by slime from stamping and cyaniding works, etc. For the most part this contamination is simply mechanical and is due to suspended mineral matters. Doubtless the effect of cyanide solutions is one of some moment in certain instances, but no investigation thereof has ever been undertaken so far as the writer is informed. Throughout the state many large canneries have been established and the number is increasing rapidly. The cannery refuse problem is becoming large in some quarters, especially where canneries are located on very small water courses and where débris therefrom is discharged directly and without pre-treatment into them. Local nuisances have thus been created in a number of cases, but they are rapidly being corrected under the law applying to nuisances because of complaints of neighbors affected thereby. It will be shown later that the state laws controlling the purity of waters apply to cannery wastes and it is hoped and expected that the State Board of Health will undertake a systematic investigation of the entire cannery problem, locating all canneries in the state with reference to bodies of water and examining these with respect to local pollution and nuisances. Thus far but very few paper mills have been established in the state. So far as the writer is informed there is only one case of serious stream contamination due to paper mill refuse and this occurs practically on the California-Nevada line. The only complaints of nuisance due to this source have been on the part of the California Fish and Game Commission and apply to fish culture. It is expected that this problem can and will be successfully solved. The refuse from beet sugar factories contains very large amounts of suspended mineral and organic matter. The daily discharge of wastes from a sugar factory of average size is about equivalent in volume to the discharge of sewage from a New England City of between 30,000 and 50,000 inhabitants. There are at the present time in California about thirteen beet sugar factories. Very few of these factories (perhaps only one or two, and certainly not more than four) discharge their wastes directly into inland waters. In a number of cases the wastes are used for irrigating adjacent lands, for which they are well adapted and very valuable: in other cases the wastes are carried to the ocean shore.

Underground Water Pollution in California.

General Conditions. Speaking generally, the underground waters of the state have not become contaminated to any considerable extent. Such pollution as exists is purely local. Ground waters taken from wells sunk beneath large cities may or may not be suitable for drinking purposes, depending upon geological and other governing factors. In the city of Sacramento, for instance, fairly satisfactory drinking waters are obtained from deep wells. Wells sunk in the city of Oakland do not, as a rule, produce satisfactory drinking water. The situation with respect to the pollution of ground waters in California is not unique and the problem does not differ in character from that met elsewhere. In more densely populated areas, problems of ground water contamination become, of course, more complex and serious.

Pollution by Residential Sewage. One serious phase of the local problem is represented by the use, in certain quarters, of deep wells in which to dispose of residential sewage. In the vicinity of Stockton, for instance, it is understood that numerous residences have been provided with small liquefying tanks whose effluents are discharged into ten-inch bored wells, whose depth is determined by the location of porous strata. The depth, therefore, varies, but in some cases is fully sixty feet and perhaps more. It is evident that ground waters taken for drinking purposes from such strata may be seriously affected even though the distance of travel may be considerable.

Pollution of Salt Waters in and Adjacent to California.

Pollution of Ocean and Bay Shores, with Sewage. The majority of coast towns and cities in California dispose of their sewage directly in Pacific Ocean without difficulty. Others have had some difficulty due to the stranding of suspended matters upon beaches in the immediate vicinity of outfalls. The most serious situation in the state is that represented by the main outfall of the city of Los Angeles at a place called Hyperion. Complaints have been made of beach pollution resulting from this method of sewage disposal and the State Board of Health and the City Engineering Department have recommended fine screening of the sewage as a first logical step in correcting this difficulty. Around San Francisco Bay large volumes of sewage are discharged by shore outfalls from the cities of Alameda, Berkeley, Oakland, Richmond, San Francisco, San José and other cities and towns. The sewage from Oakland, Richmond, San Francisco and San José is concentrated at single or only a limited number of outfalls. The outfall locations of San Francisco have been chosen with particular care. In the near future, in Alameda, Berkeley and other cities, outfall changes will be required in the nature of extensions to discharge the sewage into deep water at points where favorable currents are to be found. As

yet very few nuisances, except possibly some of a very limited extent, have been produced by sewage discharged into the bodies of salt water in and adjacent to the state.

Pollution of Salt Waters with Trade Wastes. Perhaps the most objectionable wastes, aside from sewage, discharged into the salt waters of the state, notably San Pablo and San Francisco Bays, are oil wastes of various kinds. These wastes are unsightly because of their color and density, since they are so light that they float upon the surface of the water. They also have a disastrous effect upon fish life. It is understood that the oyster industry in San Francisco Bay, due to the harmful effect of oil and possibly other wastes, including sewage, has already been injured to such an extent that it amounts to-day to only one-fourth of what it was about ten years ago and the conditions appear to be rapidly becoming worse. Similar conditions exist at Monterey and other points where oil is refined or shipped. Some of the shell-fish layings in San Francisco Bay are grossly polluted with sewage.

Controlling Legislation in California.

Public Health Act of 1907. The state legislature of 1907 passed an act known as the Public Health Act (chapter 492, Statutes of 1907, Approved March 23) which was devised and fostered by the State Board of Health. As far as the pollution of waters was concerned, this act repeated the provisions of previous legislation and ordered that no party shall discharge wastes, offensive, injurious or dangerous to health, into any body of water used or intended to be used for human or animal consumption or for domestic purposes. It was further forbidden to discharge such wastes upon lands adjacent to such bodies so that they might drain thereinto or to erect structures to discharge such wastes into or near such bodies of water so as to pollute them. The law further provided that no party shall cause or permit any livestock to pollute waters used or intended for drinking purposes. Persons were forbidden to bathe or wash clothes in such waters.

As is too often the case, no machinery whatever was provided to carry out the provisions of the law and, of course, it became ineffectual through default.

Amended Statutes of 1911. In 1911, at the request of the State Board of Health, the legislature passed an act repeating the important provisions of previous enactments and further ordaining that it shall be unlawful for house boats or other boats upon which people might live to moor within two miles of any water works intake. A unique and entirely original feature of this law was the provision that whenever any party desires to discharge or to continue to discharge any such wastes into or near bodies of water so as to pollute them, he must file a formal petition for permission

so to do. The board is authorized to undertake an investigation of each case pursuant to such an application and to charge the costs of such study to the petitioner. If it is found that the conditions are or will be such that the water will be contaminated so as to endanger the lives and health of human beings or animals or constitute a menace to the public health, such petition shall be denied but time shall be given to enable the petitioner to investigate, design and construct a new or modified system or to correct the operation thereof. If it is found that the conditions are or will be such that injurious pollution will not take place, a revocable permit will be granted, such permit to be terminated whenever the conditions become unsatisfactory. The law further provides that parties discharging dangerous wastes into waters comprehended by the act, without having an unrevoked permit to do so, may be enjoined by any court of competent jurisdiction at the suit of any party injuriously affected or at the suit of the State Board of Health. Violations of the act are defined as a public nuisance dangerous to health and subject to summary abatement.

Amended Statutes of 1913. The statutes of 1911 applied only to inland fresh waters. The legislature of 1913 amended the laws above outlined so that they now apply not only to inland waters but to all salt waters as well.

Digest of Complete Legislation now Effective. Attached hereto (Appendix I) is an outline digest of that portion of the public health act of California which applies to the protection of the purity of the inland and salt waters of the state.

Operations of the State Board of Health under the Laws.

Applications for Permits for Sewage Disposals. Under the law which became effective in 1911, twenty communities have made applications for permits for sewage disposal and have signed the blanks, which legally bind them to meet all expenses incurred by the State Board of Health in connection with the investigation and reporting thereon. In addition to these applications on the part of communities, other applications have been received for permits for the disposal of cannery wastes, hotel sewages, etc. Up to the present time most of the places making application have been visited and with respect to a number of these complete reports have been made and action has been or is being taken by the board.

The total number of applications from communities should, strictly speaking, since the law has now (effective August 10, 1913) been made to apply to salt waters as well as fresh, be equivalent to the entire number of communities having sewerage systems.* Very few communities have thus far shown any distinct antagonism to the provisions of the law and it is believed the great majority of them will, without any considerable pressure, place themselves under the law and apply for permits as the law requires.

* Except those which are remote from all water courses and dispose of their sewage by irrigation of land.

Certain communities will, doubtless, require to be forced into line through legal action undertaken by the state through the department of the attorney-general. The State Board of Health, in whose hands the enforcement of the law has been placed, has not as yet taken an aggressive stand which would have the effect of bringing in applications from all of the communities in the state having sewerage systems, for the reason that if applications were received in such numbers, the existing machinery would be entirely inadequate. The board is, therefore, cautiously entering upon its duty as an agent charged with the safeguarding of the purity of the inland waters and, generally speaking, is considering the more difficult and more serious problems first

Attitude of Communities toward Stream Pollution. California communities located upon inland waters have, generally speaking, taken a remarkably satisfactory attitude toward stream pollution and many of them, without pressure from the outside, have voluntarily provided sewage treatment plants. It is true that certain of these plants have been extremely crude; they have been ill-designed and are being poorly operated. Nevertheless, communities in general have not shown any disposition to shirk their responsibilities and when the shortcomings of existing plants are demonstrated they seem to be willing to remedy the conditions by building new or modified works or by more painstaking operation. Without question a great deal of educational and missionary work must be undertaken by the State Board of Health through its various departments in order to rouse and direct public opinion in these matters. It is believed that the quality of municipal engineering works in this state has improved greatly during recent years. There is still room for a decided improvement, however.

Engineering Organization. The legislature of California has not provided the State Board of Health with regular funds by means of which an engineering organization can be built up. The present activities of the board are comprehended by the comparatively small amount of work which can be accomplished by the consulting engineer, assisted at times by other engineers temporarily engaged upon some specific problem.

Necessity for Annual Grants and a Revolving Fund. A reading of the law will show that two funds are necessary: one, an annual grant upon the basis of which a regular permanent engineering organization can be built up; the other, a revolving fund from which engineers engaged to investigate specific problems may be paid pending the receipt of fees and expense accounts as provided for by the law. It seems to be impossible to build up an engineering organization upon the basis of the fee system alone, because the payment of these fees by the communities involved is often delayed many months and in general the returns to be expected are so variable and indefinite as to represent an unsatisfactory source of income without such a fund as that suggested.

Summary and Conclusions.

Introduction. The state of California is the second largest in the United States, having a land area of approximately 155,650 square miles. The total population in 1910 was about 2,377,500 persons, representing an average density of only 15.3 persons per square mile of land area. As respects total population, California ranked as twelfth and, as respects average density, this state ranked as thirty-fifth among the forty-eight states of the United States. Forty-five per cent. of the entire population of the state was resident in eight cities, having a population of at least 25,000. Around San Francisco Bay, and adjacent to Los Angeles, there was a population of about 1,250,000 or more than 53 per cent. of the total population of the state. At the present time there are 231 incorporated cities and towns and three sanitary districts.

There are sixteen principal river systems and very many small streams, both tributary to these river systems and with independent outfalls. The state is mountainous in character. The year is divided into practically two seasons, a wet season extending from October to March, and a dry season extending from April to September. There is a great variation in rainfall in different parts of the state and on this account the yield of streams is a very variable quantity. Owing to the long dry seasons many of the streams, especially in the southern part of the state, are intermittent in character.

Sewerage and Sewage Disposal. From the information at hand, it appears that there are 165 incorporated communities and sanitary districts with more or less complete public sewerage systems, ten incorporated communities with private sewers serving a considerable portion of the population and sixty-four places where no sewerage systems have been constructed. Summarized information with respect to the sewerage and sewage disposal of the incorporated communities is presented in Table No. 1, page 822. In addition, there are at least five unincorporated places with public sewerage systems.

Stream Pollution. There is no stream of consequence in the state which is grossly polluted with sewage. There are a few cases where small communities on very small streams are discharging sewage and sewage effluents in a way which may produce nuisances of a local character during a portion of the year. Considering the state as a whole it may be said that the æsthetic and sanitary condition of streams is at present fairly satisfactory. The pollution of surface waters by trade wastes is very limited. The wastes worthy of consideration at the present time are those resulting from lumbering, mining, canning, tanning, paper making, beet sugar manufacture and oil refining.

Underground Water Pollution in California. Speaking generally, the underground waters in California have not become contaminated to any

considerable extent. One serious phase of the problem, however, is represented by the disposal of residential sewages in deep gravel strata through wells bored for the purpose. Otherwise the problem of ground water contamination in California is not different in character from that encountered elsewhere.

Pollution of Salt Waters. As yet very few nuisances, except possibly some of a very limited extent, have been produced by the discharge of sewage into bodies of salt water in and adjacent to the state. An important exception is the Los Angeles sewer outfall at Hyperion where serious nuisances are alleged by near-by beach resorts on account of shore pollution. Objectionable pollution of salt waters, with oil wastes, has obtained in certain bays along the coast, notably in San Francisco Bay. As a consequence, the oyster industry here has been disastrously affected.

Controlling Legislation. The crude laws controlling the purity of inland waters in existence prior to 1907 have gradually been amended and extended until, at the present time, so far as legal enactments are concerned, there are provided very efficient means of controlling the quality of the inland and salt waters of the state. A complete digest of the laws now in force is presented in Appendix I.

Operations of the State Board of Health under These Laws. Pursuant to the terms of the laws which became effective in 1911, twenty communities and several industrial corporations and hotels have made application for permits for sewage disposal. No effort has been made to compel all communities and other parties in the state to make such applications because the machinery for handling them would be entirely inadequate, but real progress is being made and, thus far, no serious obstacles have been encountered, nor has the law met with decided antagonism. Undoubtedly some legal pressure will require to be brought against certain communities in order to force them to comply with the provisions of the law. Large annual grants and a substantial revolving fund should be provided in order that the State Board of Health may properly carry out the provisions of these and other sanitary laws which have now been enacted and require enforcement.

Berkeley, Cal., September, 1913.

APPENDIX I.

Digest of Statutes Relating to Sewage Disposal and Protection of Purity of Waters in and Adjacent to the State of California.

These statutes being a part of the Public Health Act of California first passed and approved March 23, 1907.

Original act applying to inland fresh waters was approved March 23, 1907; amended and approved April 1, 1911; amended, extended to include all bodies of salt water and approved June 13, 1913.

The principal provisions of the statutes relating to sewage disposal are eighteen in number and are as follows:

Section 2. (Final amendment approved April 1, 1911.)

(1) It shall be unlawful to discharge or deposit or cause to be discharged or deposited any wastes, offensive, injurious or dangerous to health, into any body of water used or intended to be used for human or animal consumption or for domestic purposes.

(a) Wastes are defined as
- sewage
- garbage
- feculent matter
- offal
- refuse
- filth
- any animal, vegetable or mineral matter or substance offensive, injurious or dangerous to health

(b) Bodies of water are defined as
- springs
- streams
- rivers
- lakes
- tributaries of above
- wells
- or other waters

(2) It shall be unlawful to deposit or discharge such wastes upon lands or places adjoining such bodies of water so as to flow or be emptied or drained thereinto.

(3) It shall be unlawful to erect (erect, construct, excavate or maintain) or cause to be erected any structure for the discharge of wastes offensive, injurious or dangerous to health, whereby such wastes may empty (empty, flow, seep, drain, condense) or otherwise pollute such bodies of water used or intended for human or animal consumption or for domestic purposes.

(a) Structures are defined as
- privy
- vault
- cesspool
- sewer pipes or conduits
- other pipes or conduits

(b) Wastes are defined as
- impure waters
- gas
- vapors
- oils
- acids
- tar
- other matter offensive, injurious or dangerous to health.

(4) It shall be unlawful to erect or maintain any permanent or temporary dwelling (house, camp, tent) so near to such bodies of water as to cause wastes to corrupt or pollute such waters.

(5) It shall be unlawful for the owner (owner, tenant, lessee or occupant) or agent thereof of any house-boat (or boat intended for or capable of being used as a residence, house, dwelling or habitation) to moor or to suffer such boat to be moored on any stream within two miles of any water works intake: provided, however, that during the process of transporting such boat it may, if necessary, be moored within this distance for a period not exceeding one day.

Section 3. (Final amendment approved June 13, 1913.)

(6) Whenever any party shall desire to deposit or discharge, or continue to deposit or discharge, into any body of water or into or upon any place from which surface or subterranean waters may run or percolate into such body of water, the same being used or intended to be used for human or animal consumption or for domestic purposes, any wastes forbidden as above, he shall file with the State Board of Health a formal petition for permission so to do.

(a) Parties are defined as any { county; city and county; city; town; village; district; community; institution; person; firm; or corporation }

(b) Wastes are defined as { sewage; sewage effluent; or other substance named above (Sect. 2, item 1.) }

(7) Whenever any party shall desire to deposit or discharge or continue to deposit or discharge any sewage (sewage, sewage effluent, trade wastes or other substances) offensive, injurious or dangerous to health in any salt water within the jurisdiction of the state, "which is or shall be a menace to public health," he shall file with the State Board of Health a formal petition for permission so to do.

(8) Accompanying such petition shall be a complete and detailed plan, description and history of the existing or proposed works or system and purification plant, showing geographical location with relation to bodies of water. Results of physical and bacteriological analysis of the substance or substances so to be discharged or deposited shall be submitted.

(9) Upon the receipt of such petition, a thorough investigation of the proposed or existing works, system and plant, and all appurtenant conditions and circumstances shall be made under the direction of the State Board of Health. Hearings may be had before the Board or an examiner appointed for the purpose.

(10) All expenses of such investigations, including hearings (except the compensation of state officers participating therein) shall be paid as they accrue by the petitioner (who is legally and firmly bound by the terms of the petition).

(11) The petition shall be denied if it is determined that the substances to be discharged will, under the conditions and circumstances which obtain, so pollute the water as to endanger the lives and health of human beings or animals or constitute a menace to the public health.

(12) If the petition applies to works constructed and in operation prior to the passage of this act, a temporary and revocable permit authorizing the continuance of such discharge may be granted to enable petitioner to investigate, design and construct a new or modified system, or to correct the operation thereof, the effluent from which shall not cause dangerous (see No. 11 above) contamination.

(13) If, under all the conditions and circumstances which obtain, it is determined that the substances to be discharged will not so contaminate any waters in question as to be dangerous, the petition shall be granted, such permit to be revocable at any time when the Board shall determine that dangerous pollution is being caused.

(14) The provisions of all laws relating to the preservation and propagation of fish and game, the deposit of débris and the obstruction of navigation must be complied with.

(15) The State Board of Health and its agents (inspectors) shall have the power, authority and permission to enter all places, for purposes of examination, to determine violations of the law.

(16) Holders of permits may, at any time, by order of the Board, be required to furnish upon demand a complete report on the condition and operation of their works, such report to be made by a competent person designated for such purpose by said Board and at the cost and expense of the holder of the permit.

(17) Parties discharging dangerous wastes into any waters comprehended by this act, without having an unrevoked permit so to do, may be enjoined by any court of competent jurisdiction at the suit of any party whose water supply is polluted or whose health shall be menaced by such discharge, or at the suit of the State Board of Health.

(18) Violations of this act shall be deemed a public nuisance dangerous to health and may be summarily abated as such.

NOTE:—Complaints of pollution of a water supply may also be made and the situation investigated and corrected under the provisions of Chap. 373 Revised Statutes of 1913, State of California. The provisions of state laws relating to nuisances may also be invoked in connection with this act in certain cases.

STREAM SANITATION IN ILLINOIS.

PAUL HANSEN,
Engineer, Illinois State Water Survey.

Read before the Sanitary Engineering Section, American Public Health Association, Colorado Springs, September, 1913.

The most conspicuous case of stream pollution in Illinois is the well-known pollution of the Illinois River by the sewage of Chicago poured into it at Lockport through the Chicago Sanitary Drainage Canal. The number of people using the Chicago sewers is approximately two million three hundred thousand. To the domestic sewage from this population are added great quantities of industrial wastes from stock yards and manufacturing plants. The dilution afforded by the water diverted from Lake Michigan into the drainage canal through the Chicago River represents about three cubic feet per second per one thousand persons tributary to the sewers.

The conditions in the drainage canal proper are not especially foul, nor is the odor in the vicinity of the canal marked, owing to the fact that most of the organic matter is still in a fresh and undecomposed condition. An exception occurs to this in hot weather when ebullition takes place in the sludge deposits in the bottom of the canal and causes large quantities of this foul sludge to rise to the surface. These comparatively unobjectionable conditions persist until Lockport is reached, thirty-five miles below the mouth of the Chicago River at Chicago. Upon entering the lower Des Plaines River, the water and sewage from the canal is joined by the somewhat highly polluted water of the Upper Des Plaines. A change in the character of the water then takes place, due to the onset of putrefactive conditions. The liquid grows darker and disagreeable odors are more pronounced. The putrefactive processes continue and reach their culmination at some point between Morris, sixty-two miles below the mouth of the Chicago River, and the Marseilles dam, eighty miles below. The point of worst condition varies with the stream flow and the season of the year, generally being farthest up stream in the winter and farthest down stream in the summer. Within this distance, the water of the river is likely to have a characteristic grayish color and is totally devoid of all life except those organisms which flourish under putrefactive conditions. Most prominent among these are *sphoerotilus natans* and *carchesium lachmanni*. Below the Marseilles dam the water of the stream begins to recover from its sick condition and this recovery is, no doubt, given an impetus by the marked aeration that occurs as a result of the flow over the dam. A normal appearance, however, does not occur in the summer time until Hennepin is reached, one hundred and sixteen miles below the mouth of the

Chicago River. Here the grayish color has disappeared and is replaced in the summer time, at any rate, by a characteristic greenish hue indicative of the presence of chlorophyl-bearing organisms. Fish life is also found in quantities that make commercial fishing profitable, but many clean water loving species are not present as formerly and the fishing, in general, is not considered as good as in past years. Sludge deposits of sewage origin are found at Hennepin and these have a bad odor in the winter time, though in summer time due to the greater activity of the organisms of decomposition, the sludge has no disagreeable odor. At points below Hennepin, the river is entirely normal and the plankton content, hence the fish food, has been greatly increased since the opening up of the Chicago Drainage Canal. The assumption may fairly well be made, therefore, that the fishing in the lower Illinois River has been greatly improved by the discharge of the sewage of Chicago into the river.

By means of dissolved oxygen determinations, the pollution of the Illinois River may be traced all the way to the Mississippi and in this distance the recovery of dissolved oxygen does not amount to more than one third of the normal. This lack of dissolved oxygen is not sufficient to have any effect on fish life, nor is it any indication of an objectionable quality of the water at points below Hennepin.

Fortunately the Illinois River is at no point used as a source of public water supply and hence this factor does not enter into the case.

Studies on the biology of the Illinois River, under the direction of Prof. Stephen A. Forbes, director of the Illinois State Laboratory of Natural History, suggest most strongly the advantage of using a biological examination of stream water as a criterion for measuring the effect of stream pollution. This has the great advantage over ordinary analytical methods in that the biology of a given point on a stream is not subject to the sudden and marked fluctuations that characterize the chemical composition of the water.

Aside from the pollution of the Illinois River by the sewage of Chicago, there are only a few important cases of stream contamination. The next most important case is the pollution of Lake Michigan by a number of towns lying to the northward of Chicago. Most of these towns are residential in character, but the northernmost, namely, Waukegan with a population of about 18,000, has a number of wastes producing industries. The industrial wastes from Waukegan have in the past given rise to a distinct nuisance, but this has been largely corrected, though not entirely eliminated. The principal objection to pollution of the north shore of Lake Michigan is the contamination of public water supplies and the fouling of beaches. The protection of Lake Michigan against undue pollution along the north shore, together with the securing of pure water supplies for the north shore communities, are related problems that are now

demanding solution and it is not probable that an adequate and economical solution will be reached unless the various communities involved can arrive at some basis for coöperation.

The next most important case of pollution which is giving rise to agitation at the present time is the pollution of the Sangamon River by Decatur, a city having a population of about 37,000. Here the dilution at low water is practically nil at the point of sewage discharge. This is due to the fact that practically the entire stream flow is utilized for public water supply above the point of sewage discharge. Near Decatur the stream is very foul and these foul conditions during the summer time extend for a distance of six to twenty miles below the city, depending upon the stage of water. Farmers living along this stream are complaining of disagreeable odors and the fact that the stream is rendered unfit for cattle watering. The city is now preparing to treat the sewage. The situation at Decatur is complicated by the presence of industrial wastes from a large starch works. When the starch plant is in operation, the pollution extends for a considerably greater distance down stream.

The pollution of a small stream known as Cedar Creek flowing through Galesburg, a city with a population of 25,000, is now giving rise to considerable complaint. This stream has in the summer time practically no flow and is grossly contaminated. The complaint comes from farmers who object to the odors and the fact that the stream cannot be used for cattle watering.

At Bloomington, a town with a population of 28,000, a small stream known as Sugar Creek is grossly contaminated, but it is interesting to note that no serious complaint has as yet been made against this condition. As the stream rises a little to the north of Bloomington, it has no natural flow in the summer time and it becomes virtually an open sewer. The sewer outlets discharge at points remote from the better residence districts and in the vicinity of packing houses and rendering plants so that the stream is the least offensive object in its neighborhood. Beyond the city the stream passes through open country and there are practically no houses on or near its bank. The bed of the stream consists of a series of riffles and pools which promotes rapid self-purification of the stream. As a rule, even in summer time, foul conditions extend only a distance of about one and three-fourths mile below the town. In the winter time or when the stream has a considerable flow, the odors may be detected as many as six or eight miles in a down-stream direction. This apparent anomaly may best be explained on the grounds that during very dry weather practically all of the sewage flow soaks away into the earth and the clear water that appears at points lower down on the stream represents accessions of ground water. This phenomenon is quite characteristic of many small towns in Illinois and has been especially observable during the past unusually dry summer.

A striking example of this was observed in the little town of Mount Sterling where sewage was being discharged into a dry run at the rate of about one hundred thousand gallons per twenty-four hours. This sewage was a very foul and offensive liquid, but within one-half mile had entirely disappeared. Nothing was to be seen but a perfectly clean and very dry stream bed.

Springfield, with a population of about fifty-two thousand, discharges its sewage into several small streams at numerous outlets. These streams wind through more or less open country and after a flow of some miles discharge into the Sangamon River. The pollution of one of these small streams is very marked and has given rise to some local nuisance, but this nuisance is taken more or less as a matter of course and has never resulted in serious complaint. The Sangamon River shows practically no visible evidence of pollution below Springfield.

There are numerous other cases of stream pollution on small streams throughout the state, among which special mention may be made of the Upper Des Plaines River and many very small streams in the vicinity of Chicago. Nearly all of the more serious complaints in this class result from injury to property, by the creation of a nuisance. Efforts in a number of instances have been made to correct the objectionable conditions by the installation of small sewage treatment plants, but as a rule these treatment plants are imperfectly operated, often of faulty design or construction and give only partial relief.

STREAM POLLUTION IN INDIANA.

JAY A. CRAVEN, C. E.

Read before the Sanitary Engineering Section, American Public Health Association, Colorado Springs, September, 1913.

Stream pollution in Indiana, as in many other states, has only been given serious consideration in the last five or six years. Although we have a number of small creeks and ditches receiving domestic sewage and manufacturing wastes, there are but two large bodies of water in which serious conditions exist, one the southern end of Lake Michigan, due principally to the Calumet River, and the other, White River. The latter, which is the worse, flows diagonally across the state, receiving sewage from Winchester, Muncie, Anderson, Noblesville, Indianapolis, Martinsville and Washington.

In 1908 (see Indiana State Board of Health Report for 1908), the sewage pollution in the lake was traced for a distance of one mile from shore, endangering the water supply of South Chicago, Whiting, Hammond, Indiana Harbor and East Chicago, as the intakes at these different cities do not extend over three thousand feet from shore. At a distance of three miles from shore the average bacteria count was found to be over fifteen thousand and B. Coli were present in 23 per cent. of the samples.

The investigation, made in 1910, of the Calumet River showed that it was seriously polluted. In the report (Indiana State Board of Health Report for 1910) on the Sanitary Survey of this river it was stated that "from this canal (at East Chicago) to the junction of the little Calumet River with the Grand Calumet, the river closely resembles a septic tank in appearances and action, where the process of the decomposition of organic matter is continually taking place." This, as stated before, causes the larger part of the pollution of the southern end of Lake Michigan bordering Indiana, and was, therefore, not considered independently.

White River, during dry seasons, has but a small flow of water and it receives domestic sewage from an urban population of 285,000, 246,000 of which are concentrated at Indianapolis. Packing houses, strawboard works and other manufacturing concerns contribute immense quantities of waste. The mean flow of the river at Indianapolis, as estimated by the United States Geological Survey in 1905, was 777,000,000 gallons and this was ten times the minimum flow. The minimum flow for the year was, therefore, 119 cubic feet per second. This is equivalent to .48 cubic feet per second per 1,000 people sewering in, considering the population of Indianapolis alone. This figure is 15 per cent. of the minimum (3.3 cubic feet per second per 1,000 inhabitants) allowed by the Chicago Sanitary District.

The condition of the river is best described in the report of Prof. R. L.

Sackett of Purdue University on the Sanitary Survey of White River which he made in 1907. "It is difficult to picture the condition of White River, in and below Indianapolis. A black deposit of oily, foul, animal and vegetable matter can be raised from the bed for miles. The weeds are coated with grease and with sewage plants. Flats are covered with blackening offal; driftwood collects dead hogs and other animal refuse where they putrify. The odor is distinct for forty miles down the river. Animals will not drink it. It cannot be used for the laundry or other domestic purposes when the cisterns and wells go dry."

One farmer living forty miles below Indianapolis and one half mile from the river said "that the odor was so strong on foggy mornings that his family cannot eat breakfast unless the doors are closed."

Under the McGinnis Act of 1909, relief from excessive pollution can be obtained when a stream is being used for public water supplies, if upon petitioning the State Board of Health, an investigation verifies the complaint.

In the case of White River, complaint was filed by the county commissioners against the city of Indianapolis and, as the river was not used by the petitioners for a public water supply, suit was to be brought against the city. Realizing the conditions, and rather than go into an expensive law suit, the city of Indianapolis coöperated with the State Board of Health and now has an experimental sewage disposal plant in operation in order to determine the requirements for a plant to take care of all the sewage of the city.

The last legislature passed what is known as the Thornton Act which concerns "the purity of water supplied to any city or town for domestic use." Under this act the burden falls upon the company or city controlling the water works to the extent, that any improvements necessary to produce a satisfactory supply, shall be made if the State Board of Health after an investigation so determines. To obtain an investigation, the board of health of any city or town, the county health officer, or citizens equal to 5 per cent. of the electors shall file a petition with the State Board of Health.

Under the Act of 1913, three cities have already filed petitions, and in the case of one, an order has already been issued to install a filter plant or change the source of supply.

No difficulties have been encountered in enforcing these acts because, although bad conditions do exist in the state as previously indicated, the work of correction has just been started. Sufficient legislation has not been passed, however, that would give the State Board of Health the authority to control the disposal of sewage and public water supplies, and such power should be invested in this body. It is hoped that the date is not far distant when this will be done.

PREVENTION OF RIVER POLLUTION IN KANSAS.

C. A. HASKINS,

Engineer in Charge, Kansas State Board of Health.

Read before the Sanitary Engineering Section, American Public Health Association, Colorado Springs, September, 1913.

The water and sewage law of Kansas, which is chapter 382 of the Laws of 1907, as amended by chapter 226 of the Laws of 1909, entitled "An act to preserve the purity of the waters of the state, for the protection of the public health, prescribing the duties of the State Board of Health in relation thereto, and providing penalties for the violation of the provisions herewith, and to provide for the naming of an engineer for the State Board of Health," among other things prohibits sewage from being discharged into any of the waters of the state without a permit from the State Board of Health, approved by the governor and the attorney-general. This permit may stipulate the conditions under which sewage may be discharged into the waters of the state and is issued for a period of not more than two years.

If at any time complaint be made to the State Board of Health by the proper health authorities of the city or county that the discharge of sewage into waters of the state is polluting such, to the detriment of public health, investigation shall be made by the board; and, if it be found that such water is being polluted in a manner dangerous to the public health, an order may be issued stating the conditions under which the discharge of sewage may continue. This order may be appealed from to the district court of the county in which the pollution occurs, and the court may modify or set aside the order. It is also provided that investigations may be made by the State Board of Health, upon its own initiative. Thus the protection of public health through the prevention of pollution of rivers and streams in Kansas, while intended to be delegated to the State Board of Health, really is dependent upon the action of the governor and attorney-general and, ultimately, upon the district court of the county in which the pollution occurs.

Sewage is defined, for the purposes of this act, as "any substance that contains the waste products or excrementatious or other discharges from the bodies of human beings or animals, or chemical or other wastes from domestic, manufacturing or other forms of industry." Thus trade wastes, oil wastes from wells, refineries, asphalt plants, mine wastes and creamery wastes, in addition to domestic sewage, are to be listed under the control of the State Board of Health, and their treatment has been studied and undertaken under advice or orders from the State Board of Health. Several orders have been issued for the treatment of oil wastes, and no little protection from nuisance has been accomplished in the oil fields of the state. Creamery waste disposal has an important part to play also in the development of the milk industry of Kansas, and studies are being made now of two or more modes of disposal of this extremely troublesome form of waste.

Naturally, the protection of those streams which are used for water supplies is what is most desired; but from the fact that many of our cities are small and do not require large quantities of water, local ground water constitutes the supply of most plants. Also, under one large portion of the state is the inexhaustible underflow of the Arkansas River; under another portion is a relatively soft supply of semi-artesian water; while under still another portion is a supply of sulphur-impregnated water, from deep wells, which may be easily aerated, furnishing a relatively soft and palatable supply. Of the 190 water supplies of the state, only about forty depend upon surface water and about twelve of these are impounded storm water supplies. Since the water and sewage law delegates authority to the State Board of Health to prescribe the manner of treatment of water supplies, a definite policy of filtration for surface water supplies has been adopted, and this is depended upon for the protection of such supplies rather than sewage treatment; but no raw sewage is permitted to flow into any streams used for water supplies. Treatment usually consists of septic or Imhoff tanks followed by contact filters.

The greater number of sewer systems are provided with disposal plants, usually, however, to prevent local nuisances. These plants consist of septic or Imhoff tanks, followed by dilution or by contact filters, depending upon the ordinary minimum stream flow. While there are no hard and fast rules controlling the amount of diluting waters, about 5 c. f. s. per 1,000 persons contributing sewage, based on a sewage flow of 100 gallons per capita daily, is desired. It is considered that a 50 per cent. saturation of dissolved oxygen is sufficient, and that no considerable amount of organic matter should be visible in the neighborhood of the sewer outlet. Often, however, these limits are reached or exceeded, particularly in such periods of drouth as is now being experienced.

Very few orders for the treatment of sewage have been issued as, ordinarily, cities are anxious and willing, when the matter is brought up squarely before them, to do what is necessary for the protection of the public health. A campaign of education brings about better results than orders or threats. One city, however, has refused to comply with orders issued for the proper disposal of its sewage for the protection of a filtered water supply some fifteen miles down stream from it; the time limit mentioned in the order is up, and the attorney-general is preparing a case, and we are anxiously awaiting the result, to find out whether or not the water and sewage law of Kansas will be upheld in court.

It should be remarked that we are also troubled by the lack of jurisdiction, federal or state, over pollution of interstate rivers such as the Missouri. Three of our most important cities are dependent on this river for water supply—Atchison, Leavenworth and Kansas City, Kans., as well as the cities of Omaha, Nebraska; St. Joseph, Missouri, and Kansas City, Mo.; and these cities also all use the river for the disposal by dilution of their sewage. Surely federal legislation to cover such streams is highly important and should be urged with all the intelligence and force available.

STREAM POLLUTION IN LOUISIANA.

J. H. O'NEILL,
State Sanitary Engineer.

Read before the Sanitary Engineering Section, American Public Health Association, Colorado Springs, September, 1913.

Louisiana has an area of 45,409 square miles and a population, according to the census of 1910, of 1,656,388. As the chief industries of Louisiana are agricultural, the population is scattered and the state has not yet been forced by intensity of population to consider seriously the problem of sewage purification.

There are only six cities in the state with a population over 10,000. All these are provided with sewerage systems. Five are situated on large rivers and, as there are no cities below using the river water for potable purposes, the sewage is discharged directly into the river without treatment.

Lake Charles, population 11,449, has recently installed a sewerage system which discharges through four outfalls into Lake Charles and Calcasieu River. As the flow of the river is at times rather sluggish, septic tanks are provided to remove the solid constituents of the sewage.

Of the cities of less than 10,000, only one, Opelousas, population 4,623, has a complete sewerage system. The sewage is treated in a plant consisting of a grit chamber, Imhoff tanks and percolating beds. The effluent is discharged into a small drainage canal. The plant has been in operation only a few months and as yet no data as to its efficiency are available.

One problem peculiar to the South, and more particularly to the southern part of Louisiana, is the pollution of small streams by the wastes from sugar refineries. The broad fertile alluvial plains of the southern part of the state are given largely to the raising of sugar cane. These plains are cut up by a network of shallow sluggish streams called bayous. These bayous serve as highways for much water traffic. Along their banks are located many sugar refineries and plantation colonies, the wastes from which are discharged into the bayous.

During 1910 and 1911 an investigation was made of Bayou Teche, one of the most important of these streams, by a committee headed by Dr. Beverly W. Smith, vice-president of the Louisana State Board of Health, and composed of ten physicians, three parish health officers, three city health officers and two sanitarians—the chief of the state engineers, the United States army engineer in charge of the gulf district, three planters, and the state analyst. Out of this committee, a sub-committee consisting of two engineers, one planter, two physicians, and one chemist, was appointed. This sub-committee was appointed to oversee the general work done in the field and laboratory.

Three trips were made from the mouth of the Teche to Morbihan and a

final trip was made in 1911 as far as St. Martinsville. Field surveys and analyses were made; samples were collected and complete analyses were made in the laboratory.

The Teche is a long, narrow, winding stream with a sluggish current. During the grinding season it is practically stagnant. The average width of the watershed is about 2,000 feet and varies from very steep banks to very gradual slopes.

The sources of pollution are as follows:

1. *Wastes from the population along its banks.* There are ten towns on the bayou varying in population from 300 to 9,000, and many farms between these, making a total population of 27,000 whose discharge might get into the bayou. None of the towns has a general sewerage system, but all have a few private sewer lines. The open-back surface toilet is common in this section and rains wash much pollution from the closets into the bayou.

In addition there is also a considerable amount of pollution from vast numbers of mules, horses, pigs, sheep, dogs, poultry, etc., from the farms and stable-lots on the banks of the bayou.

2. *Sugar refinery wastes.* There are twenty large sugar refineries along the bayou, with a total capacity of one hundred million pounds per season. The bayou water is used for cooling the evaporating pans and, there being little current to carry it off, it goes back and forth from the mill to the stream in a constant circle until it has lost much of its oxygen by being heated, and so is deprived of its purifying powers.

The "sweet water," that is, the condensed vapors from the evaporating pans is also discharged into the bayou. It is estimated that about 3,000 pounds of sugar out of every million pounds manufactured are lost in the sweet waters through entrainment, sugar being only one of the decomposable substances carried over in this manner. Estimating the sugar production of the Teche proper at one hundred and fifty million pounds, we have four hundred and fifty thousand pounds of sugar polluting the Teche each season.

Sanitary surveys and analyses show that even at its best, namely during high water, the Teche is taxed to its capacity for caring for organic wastes from the first two sources at all times of the year.

Therefore, when the additional burden of the refinery wastes is put on the natural purification processes they prove to be utterly inadequate. The stream is almost wholly deprived of its dissolved oxygen, the fish are killed and the noxious odors of decomposition become almost unbearable in some sections.

The remedies proposed were:

First, to prevent pollution of the stream by all animal matter at all times of the year by proper sanitary observances.

To protect the stream from all possible sugar-house wastes and material containing organic matter.

Second, to turn into Bayou Teche, a large volume of fresh water, in order to maintain a constant current and prevent the sluggish condition of the stream.

Plans have been made by the United States and the state engineers for the joining of Bayou Courtableau to Bayou Teche, which would insure a constant current in the Teche, but the execution of these plans has been so far held up by the opposition of powerful irrigation interests.

Much good, however, has been accomplished by the general cleaning of the banks of the Teche and by the discharge of organic wastes over the crest of the ridges on both sides of the Teche.

STREAM SANITATION IN MAINE.

H. D. EVANS,
Director Laboratory of Hygiene.

Read before the Sanitary Engineering Section, American Public Health Association, Colorado Springs, September, 1913.

There is but one sewage disposal plant in the state. That one is located on the National Reservation, at Togus. It consists of a couple of small sprinkling filters, and was installed to rid the small brook, into which the sewage from the home was discharged, of a nuisance. The plant, when properly attended to, gives very satisfactory results; but, unfortunately, it does not receive such attention at all times.

The polluting wastes in our rivers and streams at the present time are sulphite pulp wastes, and domestic sewage wastes. Formerly sawmill waste, especially sawdust, entered our rivers in large amount; but there is now a statute law prohibiting the entrance of such waste into any of the streams of the state.

None of our rivers are in a state that would be called a nuisance. The large size of the rivers, their comparatively even flow, as they head in the wild lands, and the relatively small amount of trade waste that enters them has resulted in a normal appearing river, even within four miles of our largest pulp mills.

Domestic sewage has, however, unfitted all of our rivers for drinking use, unless the water is first filtered. Owing to the abundant supply of ground water in the state, and the great number of lakes and ponds, we always raise objections to the use of a river or stream as a source of public water supply in this state.

Our six large rivers, flowing south, are all unfit for drinking, owing to this pollution. The Saco becomes polluted twenty miles from the sea; the Presumpscot, fifteen miles from the sea; the Androscoggin is polluted throughout its entire length in this state, receiving its initial dose across the New Hampshire line; the Kennebec is polluted 100 miles from the sea; the Penobscot, 150 miles inland; and the St. Croix, about twenty miles from the sea. Of the rivers flowing north all are in the wild lands, save the lower reaches of the Aroostook, which is polluted below Ashland, about sixty miles from its junction with the St. John.

All of our rivers are in good physical condition, and can take care of many times the volume of sewage they are now receiving without becoming a nuisance. The present amount of trade and domestic sewage waste has hardly touched their oxygen content. Our entire trouble is with domestic wastes.

STATE CONTROL OVER WATER SUPPLY AND DRAINAGE CONDITIONS IN MARYLAND.

ROBERT B. MORSE,
Chief, Bureau of Sanitary Engineering, Maryland State Department of Health.

Read before the Sanitary Engineering Section, American Public Health Association, Colorado Springs, September, 1913.

NEED OF CONTROL IN MARYLAND.

The desirability of legislation, giving a State Board of Health broad supervisory powers and duties in connection with the regulation of water supply service and stream pollution, is perhaps universally recognized and the reasons for it are generally understood. Therefore, only those conditions will be mentioned here which tend to make central control more essential in Maryland than in many states at the present time. The most apparent of these are:

1. The scarcity of proper and adequate water supply and sewerage systems.
2. Lack of local government in vicinity of Baltimore and Washington.
3. Prevalence of typhoid fever.

Water supply and sewerage facilities in Maryland are unsatisfactory in the extreme. While practically all communities of any considerable size are supplied with public water systems, many of these seem to have been constructed with almost the single objective of cheapness in view, and many are at present delivering unsafe water. Purification works are rare, and properly operated ones rarer still. Wells have been driven in thickly settled localities, and improperly protected surface supplies are generally used without treatment. In many of the towns supplied with water, private wells are still in more or less general use; and this is the case even in some places which maintain public supplies of good quality.

Many towns have a few sewers, and some have what may be called partial systems, but few are completely sewered. It is well known that Baltimore had, until recently, no sewerage system worthy of the name, and this system cannot be completed in all parts of the city for a year or two to come. Inadequate as are the means for collecting the wastes, provisions for their treatment are still more so. Sewage is discharged, in most cases, without reference to resulting dangerous and offensive conditions. As a consequence, many streams in the more populous districts, and several harbors, are foully polluted. It is only fair to say, however, that a few communities have recently built satisfactory sewage treatment works.

That Maryland is so poorly served with water supply and sewerage facilities is partly due to apathy and a lack of realization of the needs of modern life on the part of many inhabitants, and partly to the lack of money; but the greatest factor is the short-sighted policy of municipal officials, who think they are keeping down expenses on public works by dispensing with the services of an engineer, or by engaging an engineer of inferior qualifications, with the resulting establishment of improperly protected or uneconomically operated water supplies, and poorly designed sewerage systems which are uneconomical in construction, unsatisfactory in maintenance and operation, and which create dangerous or offensive conditions in the bodies of water into which they discharge.

The second point mentioned as making state supervision over all water supply and sewerage questions in Maryland especially essential is the curious fact that in the neighborhood of Baltimore there are no incorporated communities, and that in the vicinity of Washington much of the territory is also under county government only. Baltimore County,* with a population of nearly 140,000, almost entirely surrounds Baltimore City. From 1900 to 1910, its population increased at a rate of about 35 per cent. A very large proportion of the total population resides within a few miles of the city boundary. Practically all of the territory in the county outside of the suburban zone decreased in population between 1900 and 1910, and, therefore, it is evident that the territory just outside of Baltimore City is growing at an exceedingly rapid rate. The county is governed by three commissioners. Taxes are levied on the county as a whole, and improvements in the various localities are hard to obtain. Very little money has been spent for sewer construction, and large areas have become densely populated, with no provision whatever made for the collection and disposal of sewage. This neglect has resulted in deplorable sanitary conditions at many points, some of which are due to inadequate systems of sewers built by real estate developers, and others to the entire absence of sewers.

Conditions around Washington are somewhat similar to those near Baltimore, but are in general not quite so critical, as the population is not so large and the incorporated parts of the territory are not entirely dependent upon county government for the institution of public works.

The third reason mentioned for strict state control over water and sewerage questions in Maryland is the unenviable position which the state holds in respect to the prevalence of typhoid fever. Mortality from this disease is from twice to four times as great as in other eastern states, such as New York and New Jersey, and the New England States. And it is a fact that Maryland has had almost the highest mortality from typhoid fever in the whole registration area of the United States, ever since 1906,

*Baltimore City is not a part of Baltimore County.

the year that the state became a portion of that area. Moreover, in strong contrast with almost all the other registration states, there was no substantial decrease in the typhoid fever death-rate between 1906 and 1911; and the rate in Maryland was practically constant for at least twenty years previous to 1911.

In this state there are many more cases of typhoid fever than of any other communicable disease reported, except tuberculosis and measles, and during some years even these are exceeded by a considerable margin. It is also true that, with the exception of tuberculosis, typhoid fever is the direct cause of many more deaths every year in Maryland than any other communicable disease.

Existing Laws.

The need for controlling water supplies and stream pollution in Maryland became so well recognized by the year 1910 that a law was enacted creating, among other special divisions of the State Board of Health, a bureau of sanitary engineering. The appropriation allowed was so small, however, that it was impossible to organize this bureau until May, 1912, just prior to which time a larger appropriation had been granted.

At the time the law prescribing the duties of the bureau of sanitary engineering was prepared, it was feared that strict measures for the control of water supply and sewerage service would fail of passage, and it was, therefore, deemed wise to provide at first for investigation and study, rather than regulation, of conditions. The duties of the bureau may be briefly summarized as follows: the examination of, and the recording of plans relating to, all public and private systems of water supply and sewerage in the state; reporting upon the sanitation of public buildings; investigating offensive trades and nuisances, the disposal of trades wastes and sewage; and devising means for the improvement of unsanitary conditions. There is nothing in the law creating the bureau which gives it power to do more than recommend. Whatever, then, is done in Maryland towards the regulation of water supply and sewerage service must be accomplished under old legislation; and there are very few specific provisions under which the State Board of Health can act. It is natural that early legislation should deal almost wholly with the control of disease, epidemics and nuisances after they existed, rather than to prescribe measures which would tend to prevent their occurrence.

Under existing conditions, the bureau of sanitary engineering is called upon for advice in many cases involving new water and sewerage systems or improvements in old ones, and often its recommendations are followed, but the submission of plans for approval is optional, except in the case of the establishment of sewerage systems by the county commissioners of Baltimore County; and there seems to be nothing to prevent the utilization of any source of water supply whatsoever, nor to give the state power

to interfere with the construction of any form of plant. Until the harm is done, the State Board of Health has no jurisdiction.

If a water supply is found to be polluted, or if a body of water is in such an offensive state as to create a nuisance, the State Board of Health can take action, causing the condition to be remedied. The laws under which this is possible are briefly as follows:

1. A law prohibiting the pollution of any source of water or ice supply used for drinking or domestic purposes, by allowing sewage, trades-wastes, or any filthy animal or vegetable matter to reach it.

2. A law prohibiting the discharge of earth, ashes, filth, etc., from any boat, into any river, tidal creek, harbor or the northern portion of Chesapeake Bay.

3. A law empowering the State Board of Health to order the abatement of nuisances, or conditions dangerous to health, that may occur in or about any water-course, well, cesspool, ditch, drain, etc., and to order the execution of such works as may be necessary to accomplish this purpose.

Penalties are provided for refusal to comply with the provisions of these acts, and enforcement is possible through the circuit courts of the several counties and of the city of Baltimore.

It may seem as if there were sufficient law to keep water supplies and streams in Maryland in good condition, but it is plain that practically all improvement must come through enforcement of the nuisance law. It is through this channel almost entirely that owners of polluted water supplies can be forced to deliver pure water, for it is seldom that sufficient improvement can be effected by taking action, under the water supply law, against all contributors of polluting matter. It is high time that the State Board of Health be given, by legislation in specific terms, strict supervisory powers and duties, which will insure the construction of water and sewerage systems of a proper character, and not merely allow the correction of flagrant abuses.

Enforcement of Existing Laws.

Even with the laws at present existing, it would appear as though water supply and sewerage conditions in Maryland ought to be much better than they are, but it must be remembered that until about a year ago there was no engineering department in the State Board of Health and very little money was available for carrying on work necessary to such an end. Petty nuisances had been abated by local health authorities, and complaints regarding offensive conditions had been investigated by the State Board of Health, but no systematic investigation of water supplies and stream pollution could be undertaken.

Since the establishment of the bureau of sanitary engineering, the work

of examining all water supplies, sewage disposal works and stream pollutions has been started and is being carried along as systematically and rapidly as special investigations of various natures and a small appropriation will allow. Whenever improper conditions are found, adequate improvements are proposed by the bureau. If the recommendations are not followed, or equally effective changes made, an order embodying specified requirements is served, and a reasonable time is allowed for compliance. This method of handling such situations is of recent origin, and since its institution a considerable degree of success has attended its operation. As yet it has been unnecessary to appeal to the courts.

A consideration of the enforcement of sanitary legislation in Maryland brings to attention a court case which is of importance and interest, not only as upholding the supremacy of the law, but on account of the boldness with which public officials sought to disregard the law, spend the public funds and defy public opinion, the amount of money involved, the length of the case, and the volume of expert testimony taken.

In the summer of 1912, a sewage disposal plant of a patented type, together with tributary sewers, was completed by a private company near Mount Washington, a settlement in Baltimore County, about one and one-half miles north of Baltimore City and in the valley of Jones Falls. These sewers have a total length of slightly less than ten miles and serve, at present, part of the settled territory in the valley of Western Run, a stream tributary to Jones Falls, having a drainage area of about four thousand acres.

In September, it became known that the use of the Mount Washington disposal works was being considered by the county commissioners as the nucleus of a public sewerage system for the Jones Falls valley. Accordingly, the advisability of such action was investigated by the bureau of sanitary engineering. This resulted in a report to the State Board of Health by the writer, in which it was stated that the use of this plant would be unwise, since the sewerage problem in that locality had received insufficient study, and also since the plant was privately owned, improperly located for the purpose for which it was wanted, of an untried type, of faulty design, had been unnecessarily expensive in construction and would be so in operation, that patent litigation was to be feared, and that it was merely a clarification plant and would be incapable of furnishing an effluent of proper quality for discharge, in large quantities, into Jones Falls. Just as this report was completed, it became publicly known that the commissioners were considering the purchase of the plant and sewers for the sum of $600,000. The writer protested immediately against such a transaction, stating that main trunk sewers and a disposal plant for the whole Jones Falls drainage area would cost only about $250,000 and that the $600,000 would be practically wasted.

In Baltimore County, and in no other part of Maryland, there is a law, passed in 1912, providing that no sewerage system shall be established by the county commissioners except in accordance with plans approved by the State Board of Health. Notwithstanding this, the state's protest was given no consideration by the board of commissioners and was, in fact, kept secret from one member. A former chief engineer of the Maryland State Roads Commission was engaged to advise the commissioners concerning the purchase. About a week after his employment, this engineer submitted a report valuing the property at the suggested purchase price. He estimated the cost of plant and sewers at $300,000, while the remaining value was made up, in his judgment, of entrance contracts, patent rights, stream control, etc., factors which were, in reality, almost worthless to the public. In spite of the State Board of Health's protest, and in apparently reckless disregard for the law, the county commissioners purchased the property on the very day the report of their engineer was submitted, without even giving a public hearing on the question.

The haste and secrecy with which the deal was closed, together with the seemingly exorbitant price and failure to receive the approval of the State Board of Health, so aroused public sentiment that a number of citizens instituted proceedings in the circuit court of the county, against the commissioners and the sewerage company, to have the sale set aside, alleging fraud, unfair price and lack of approval by the State Board of Health. This board also asked the court to annul the sale, for the last-named reason. The state's case was held in abeyance, pending a decision on that of the taxpayers.

A detailed examination of the system was made by the force of the bureau of sanitary engineering. The plant was found to possess defects in design which would render it of little value when the sewage flow became normal in volume. The sewers were found to be poorly designed and built. It was estimated that the cost of constructing the entire work was $82,000. This system, together with rights of way and several acres of land, was, in effect, what the public was to get for $600,000.

The trial of the case occupied forty-five court days. Much technical testimony was introduced on both sides. The decision of the court was to the effect that the county commissioners had no power to purchase the system without the approval of the State Board of Health, and that the sale was therefore void. It did not deal in detail with the other points at issue. The case was not appealed and the matter is therefore at an end for the present at least. The testimony and the final decision fully justified the position maintained by the State Board of Health, and it is to be hoped that the trial of the case will mean much for better sanitation in Maryland, as it has brought forcibly before the people the need for strict state control over matters affecting the public health.

LAWS RELATING TO THE PREVENTION OF RIVER POLLUTION IN MASSACHUSETTS.

X. H. Goodnough,
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Read before the Sanitary Engineering Section, American Public Health Association, Colorado Springs, September, 1913.

In response to requests from members of the Association, I present herewith a brief description of the legislation of the state of Massachusetts relating to the prevention of the pollution of streams, the authority of the State Board of Health under existing laws and a general statement of the results accomplished in the enforcement of these laws.

In the consideration of these questions, it is of course not intended to discuss the question of the pollution of streams so far as it may affect their use as sources of domestic water supply. The use of unpurified river waters for domestic water supply in Massachusetts was discontinued long ago in accordance with recommendations of the State Board of Health, and in only one or two instances are river waters used for domestic purposes in Massachusetts, even after purification. The question considered herein is the problem of the prevention of the pollution of streams from the point of view of the health and comfort of those dwelling along their banks or in their neighborhood.

History.

Interest in the question of stream pollution in Massachusetts was very probably first aroused by the agitation of this question in England, and the first studies of the general condition of Massachusetts streams were made by the State Board of Health in the early 70's. Apparently the first legislation of importance relative to a study of the question of the condition of streams was enacted by the General Court in 1875. The important portions of this act are as follows:

> . . . The state board of health shall investigate by themselves or by agents appointed by them, the subject of the correct method of drainage and sewerage of the cities and towns of the Commonwealth, especially with regard to the pollution of rivers, estuaries and ponds by such drainage or sewerage, and to devise and report a system or method by which said cities or towns may be properly drained, and said rivers, estuaries and ponds may be protected against pollution, so far as possible, all with the view to the preservation of the health of the inhabitants of this Commonwealth, and the securing to the several cities and towns thereof a proper system of drainage and sewerage, without injury to the rights and health of others; also, to report how far said sewage may be utilized and disposed of . . . . (Section 1, Chapter 192).

In its report, published in 1876, upon the question committed to it by the above legislation, the board finds that no control over the streams was exercised at that time by anyone, all of the waters being left to the ordinary rules of common law.

The following is an extract from the conclusions expressed in this report concerning the matter of stream pollution:

> . . . Any defence of their waters against impurities which so conveniently flow into them from the settlements and works on their banks has thus far been merely nominal; that is, the law can be used to prevent a nuisance from continuing to be poured into the river, but it is not used because the process is too slow, cumbersome and expensive. . . .

As a result of the investigation, the board made certain recommendations, of which the following are the more important:

> 1. That no city or town shall be allowed to discharge sewage into any water course or pond without first purifying it according to the best process at present known and which consists in irrigation, provided that this regulation does not apply to the discharge of sewers already built—unless water supplies be thereby polluted; provided also that such intended discharge can be shown to be at such point or points that no annoyance will arise from it.
>
> 2. That no sewage of any kind, whether purified or not, be allowed to enter any pond or stream used for domestic purposes.
>
> 5. That steps should be taken by special legislation based upon investigations and recommendations of experts to meet cases of serious annoyance arising from defective arrangements for the disposal of sewage.
>
> 6. That irrigation be conducted at first experimentally at those places where some process of purification of sewage is necessary and that cities and towns be authorized by law to take such lands as may be necessary for that purpose.
>
> Finally, the Board feel that in the present state of our knowledge, sweeping laws for the general and immediate purification of all of our streams would be hardly justifiable and that they are not called for by the present condition of our rivers.

Following the report of 1876, the question of the prevention of the pollution of certain rivers rapidly became a most pressing one and special reports upon the Blackstone River and investigations of other streams were made from time to time until 1884. In the latter year a statute was enacted creating a special commission, afterward known as the Massachusetts Drainage Commission, to consider and report upon a general system of drainage for the relief of the valleys of the Mystic, Blackstone and Charles Rivers and for the protection of public water supplies within the basins of said rivers. This commission was also directed to consider the various methods of sewage disposal and the application of such methods in preventing pollution of the streams of these valleys, etc.

The commission considered the subject very thoroughly and in 1886 made a comprehensive report upon the whole question of the control of inland waters and the prevention of the pollution of streams.

This commission recommended the appointment of a board to have general oversight and care of the inland waters of the State, with power to

advise cities, towns, manufacturers and others as to the disposal of their sewage and wastes with the view of the protection of the public interest. Concerning the duties and powers of the proposed board, the commission advised in part as follows:

> Let these guardians of inland waters be charged to acquaint themselves with the actual condition of all waters within the state as respects their pollution or purity, and to inform themselves particularly as to the relation which that condition bears to the health and well-being of any part of the people of the commonwealth. Let them do away, as far as possible, with all remediable pollution, and use every means in their power to prevent further vitiation. Let them make it their business to advise and assist cities or towns desiring a supply of water or a system of sewerage. They shall put themselves at the disposal of manufacturers and others using rivers, streams or ponds, or in any way misusing them, to suggest the best means of minimizing the amount of dirt in their effluent, and to experiment on methods of reducing or avoiding pollution. They shall warn the persistent violator of all reasonable regulation in the management of water, of the consequences of his acts. In a word, it shall be their especial function to guard the public interest and the public health in its relation with water, whether pure or defiled with the ultimate hope, which must never be abandoned, that sooner or later ways may be found to redeem and preserve all the waters of the state. We propose to clothe the board with no other power than the power to examine, advise and report, except in cases of violation of the statutes. Such cases, if persisted in after notice, are to be referred to the attorney general for action. Other than this, its decisions must look for their sanction to their own intrinsic sense and soundness. Its last protest against wilful and obstinate defilement will be to the general court. To that tribunal it shall report all the facts, leaving to its supreme discretion the final disposition of such offenders. If such a board be able to commend itself by its conduct to the approval of the great court of public opinion, it will have no difficulty, we think, in materially reducing the disorders and abuses which are threatening to give great trouble in the future if not speedily checked. If, however, we err in this expectation, and more drastic measures prove indispensable, the mandate of the state can always be invoked to reënforce its advice.

The Legislature of 1886, acting on the advice of the Massachusetts Drainage Commission, passed a law embodying the conclusions of that commission and committed its enforcement to the State Board of Health. Two years later, the law was amended by providing that all petitions to the legislature for authority to introduce systems of water supply, drainage or sewerage should be accompanied by the advice and recommendation of the State Board of Health thereon. Most important among the provisions of this law was the authority to conduct experiments upon the purification of sewage and manufacturing waste.

It was thus made practicable for the board through its own investigations and experiments to obtain reliable information as to the applicability of methods of water and sewage purification to the conditions found in Massachusetts and to give definite and practical advice as to the best methods available for solving the problems presented. With the continued operation of the experiment station, which has been maintained since this law was first put into operation, it has been practicable to study thoroughly all questions relating to the purification of water, sewage and manufacturing waste and develop new methods, and frequently to anticipate new prob-

lems requiring special methods of treatment. The board was thus enabled to advise with authority as to practicable and available methods for the purification of the sewage and waste by which the streams were becoming defiled and, taken in connection with the results of studies of the effect of the discharge of sewage and manufacturing waste upon streams under various conditions, it was possible to regulate their use as places of sewage disposal with due regard to the public health and the interests of all concerned in the condition of the rivers of the State.

The effect of this law was to provide that no sewage should be disposed of in the future from any city, town, or village, until the plans of the system and method of disposal had been passed upon by the State Board of Health. There was no penalty for failure to follow the advice and recommendations of the board, and in the earlier years works were built in one or two cases which did not conform to the board's recommendations; but since the legislature, very soon after the passage of the law, began the practice of inserting in practically all special acts relating to sewerage a proviso requiring the approval of the plans by the State Board of Health, the recommendations of the board came to be more closely followed.

The law of 1886, as subsequently amended in 1888, was supplemented in 1902 to the extent of requiring an annual examination and report to the legislature by the State Board of Health on the condition of all main outlets of sewage and drainage in the cities and towns of the Commonwealth and the effect of sewage disposal.

In later years, as a result of the examination of sewer outlets under this law, it was found that sewage disposal works in some cases were not operating satisfactorily, either from lack of sufficient capacity or of proper care, or on account of the introduction of matters into the sewers which interfered with the operation of the disposal works, and in response to recommendations, authority was granted by a statute of 1909 to regulate the character of waste liquors discharging into the sewers of cities and towns having disposal works and to require the enlargement or efficient maintenance of such works where such improvements might be necessary.

The general legislation relative to the prevention of the pollution of streams in Massachusetts is comprised substantially in the laws thus far mentioned. These laws do not apply to the Connecticut River—the largest stream in the state—and were not applicable to the Merrimack River until a law was passed in 1909 amending the statutes relative to the prevention of the pollution of streams as to make them apply in the case of the Merrimack River so far as the discharge of sewage into this stream was concerned. Each of these rivers receives considerable sewage pollution before entering the state, and this fact was, doubtless, of influence in causing them to be excepted from the provisions of law applied to other rivers.

Results Accomplished under the General Laws Relating to the Prevention of the Pollution of Streams.

At the time of the passage of the act of 1886, as nearly as can now be determined, sewerage systems had been provided in twenty-eight cities and towns, which served large sections of the more populous areas in those municipalities. There were also partial systems of sewers in many other cities and towns. In most of the older and larger municipalities drains had been constructed at an early time for the removal of surface water and ground drainage and came later to be used for the removal of sink drainage and other sewage. These drains have been superseded and their use discontinued where modern systems of sewers have been introduced, but such drains are used even at the present day in many of the smaller towns and villages. In the earlier times they were usually constructed of wood or stone, but more recently earthen pipe has usually been employed. They are built in most cases by private parties, often without manholes, and it is usually impracticable to find a record of the location of the sewer or the number of connections therewith.

The modern sewerage system was first introduced from England, having been copied largely from the sewers of London, where both sewage and rain water were being removed in the same channels, but when adapted to a region like New England with a much higher rainfall, it often happened that very large sewers were required to convey the sewage to a proper outlet, whereas for the disposal of surface water and ground drainage alone, shorter and consequently smaller channels would have been adequate and satisfactory.

These conditions led to the development of the separate system of sewerage, the advantages of which had become evident to sanitary and hydraulic engineers by the time the first laws relating to the prevention of the pollution of streams were enacted in Massachusetts, but these advantages were not so obvious to the members of municipal governments, and in some places it was many years before city and town governments generally could be convinced of the disadvantages of the continued extension of combined systems of sewers, especially in those places where the treatment or purification of the sewage was likely to become necessary. In consequence, combined systems of sewers are still the rule in the cities and large towns in Massachusetts, but are not found in smaller places where systems have been introduced in more recent years.

When combined systems are in use, it is usually impracticable, when purification becomes necessary, to deal with the entire quantity of sewage and storm water discharged from the sewers in many of the cities and towns in the State, since the complete prevention of the discharge of sewage into a stream in such cases requires either the reconstruction of practically the

entire sewerage system in order to reduce within practical limits the quantity of sewage to be treated or else an excessive outlay for the construction and operation of disposal works. The cost of either plan is in most cases prohibitive unless extended over a considerable period of years.

As a practical matter, however, the attempt either to treat all of the sewage and storm water in such cases or to effect promptly the separation of the systems is usually unnecessary. There is no doubt that a stream or river of considerable size may be used as a place of disposal for a considerable quantity of sewage without appreciable harm, and in any case it is impracticable to prevent more or less pollution of the streams in a thickly populated state like Massachusetts, even with the most complete and efficient systems of sewerage, drainage and sewage disposal thus far devised. Especially is this true of a river basin containing large urban populations, where much pollution will inevitably reach the streams, even though efficient sewerage and sewage-disposal systems are in operation in all urban districts.

Under these circumstances the usual practice has been followed, that is, in cases where the sewage of a combined system of sewers requires removal or further treatment, the dry-weather flow of sewage only is cared for, including an allowance for small rains and thaws, allowing the excess of flow at times of heavier rains to continue to discharge as before. As necessity arises, the separation of the systems of sewers is effected gradually so that eventually, if necessary, all of the sewage can be treated and the pollution of the stream prevented. The separation of sewage from storm water is already being effected in large areas of the city of Boston and other parts of the Metropolitan District, as well as in several other cities and towns.

Next to a wholesome and adequate public water supply the most important factor in the improvement of the sanitary condition of thickly settled communities is an adequate and effective system of sewerage and drainage which shall remove promptly all domestic sewage and other foul wastes from the neighborhood of dwelling houses, carry off the surface water and thoroughly drain the land, and, in carrying out the laws relating to the prevention of the pollution of streams in Massachusetts, every effort has been made to promote as rapid an extension as possible of the benefits of sewerage and drainage in thickly populated districts and at the same time to maintain the streams in a condition which shall not be objectionable or injurious to the public health by reason of sewage pollution.

In view of these considerations—viz., the impossibility of preventing all pollution of a river in a more or less thickly populated valley, the natural capacity of a stream to absorb a certain amount of pollution, often without injury to the health or other interest of those dwelling farther down the valley, and the great importance of sewerage and drainage in densely populated communities—it has not been the invariable rule to require the

purification of the sewage upon the installation of a new system in a city, town or village, but to consider carefully the conditions in each case presented, including the financial resources of the community, and to adopt the course which seemed best under all the circumstances. In consequence, whenever conditions have been found in which the admission of sewage to a stream is permissible, such a method of disposal has been advised, usually for a definite period, but always with the limitation that the sewage shall be removed from the river and treated whenever, in the opinion of the Board, such a course becomes necessary.

From the time of the passage of the act of 1886 to the end of 1912, the total number of cities and towns having systems of sewers had increased from twenty-eight to 104. Of that number, twenty-two cities and towns are included in the north and south metropolitan sewerage systems, the sewage from which is discharged into the sea at two points in the outer part of Boston Harbor; fifteen others, including the city of Boston, also discharge their sewage into the sea at various points along the coast, making a total of thirty-seven cities and towns in the state having sewer outlets into the sea. The remaining sixty-seven cities and towns discharge their sewage in all cases into inland waters; of that number, thirty-two, or nearly one half, maintain purification works for the treatment of all or a part of the sewage before it enters the stream, leaving thirty-five cities and towns which at the present time discharge their sewage untreated into inland waters. Of this number, sixteen dispose of their sewage into the Connecticut and Merrimack Rivers, the former of which is excluded from the laws relating to the pollution of streams and the latter of which was also excluded until 1909. Of the nineteen cities and towns which at present discharge sewage into inland streams other than the Connecticut and Merrimack Rivers, about half were already provided with sewerage systems at the time of the passage of the act of 1886. The municipalities which have been authorized to discharge sewage temporarily without treatment into inland waters consist for the most part of comparatively small towns. In these cases the board has advised the discharge of untreated sewage directly into the river for a limited period, usually specified, but such disposal of the sewage is to cease at an earlier time if required by the board. In the cases which have arisen where such permission has been granted and subsequently terminated, no serious difficulty has thus far been experienced in securing compliance with the conditions specified.

While the number of cities and towns discharging sewage into inland rivers, other than the Connecticut and Merrimack, is somewhat greater than when the work of the board was first begun, the population of these places is for the most part small, the towns are very widely scattered and the condition of the river in their neighborhood and below is subject to regular and careful examination, in order that when the conditions appear

to require treatment of a part or all of the sewage the necessary works can be provided in sufficient season.

Sources of Pollution not Affected by the General Legislation Relating to the Prevention of the Pollution of Streams.

The effect of the application of the legislation thus far considered to the rivers of the state has been to arrest the increase in the pollution of streams and, to some extent, to recover ground lost in the years before the law was enacted, but the law of 1886 was not retroactive, and cities and towns which had already constructed sewerage systems discharging into the rivers of the state were not affected by that law. In a few of these cities purification works were installed at a later time or the sewage removed to some suitable outlet other than in the streams, but in most cases the discharge of crude sewage directly into the rivers by these cities and towns has been continued to the present time.

In some of these cases the disposal of sewage by this method has not thus far created notably objectionable conditions, but in a number of cases where the conditions have become seriously objectionable the board has endeavored to induce the city or town responsible for these conditions to discontinue the pollution of the stream after it became evident that such pollution was likely to be objectionable, and in a few cases the work has been taken up and carried out by the town without further action. A notable instance of this is the cleaning up of the Ten Mile River in the southeastern part of the state which had become badly polluted by the sewage from Attleboro and North Attleboro, towns which have an aggregate population of about 25,000. Acting under the recommendations of the board, and without being required to do so by law, these towns have installed works adequate for the complete purification of all of their sewage.

In other cases where no action could be secured on the part of the municipality responsible for the objectionable pollution of a river, the matter has been reported to the legislature and an effort made to secure the necessary legislation to require the treatment of the sewage, but very little success has attended these efforts.

The most notable result thus far secured in a recent attempt of this kind was a report of the drainage committee of the legislature that in its opinion the city in question should do something to relieve the river of the pollution caused by its sewage. Even this slight notice on the part of the legislature appears, however, to have had sufficient force to secure the construction of sewers and sewage disposal works by that city.

There still remain a few cases where the objectionable pollution of a stream is caused by the discharge from sewerage systems which were in existence before the passage of the law of 1886, yet no action has thus far been taken by the legislature to supply authority to prevent these pollu-

tions. These inequalities in the law have resulted in some cases in producing curious anomalies in the treatment of the stream pollution question in different valleys. One of the most notable of these is the situation in the Housatonic Valley in which sewerage systems have been installed in one city and five towns. Three of these municipalities have provided themselves with purification works, under the requirements of the State Board of Health, but in two of the other three, sewerage systems were in existence previous to the passage of the law, while in the third the construction of a sewerage system was authorized by the legislature without regard to the law of 1886, and these three towns continue to discharge sewage untreated into the stream. There has been a marked increase in the pollution of the river in this valley and an agitation has arisen that all of the towns shall be required to remove their sewage from the stream. It is not improbable that special legislation may be sought for the improvement of this river similar to that which has been enacted in the case of certain other rivers, of which mention will later be made.

Further Legislation Relating to the Prevention of the Pollution of Streams.

While the general laws already described are clear and well-defined in matters relating to the pollution of streams by cities and towns, the powers delegated to the State Board of Health for the purpose of preventing the pollution of streams by manufacturing waste were less specific, though they require the board to consult with manufacturers as to the purification of their wastes and authorize experiments to ascertain the practicable methods of treatment.

In certain of the rivers, manufacturing wastes rapidly came to be the chief causes of objectionable pollution, and this condition has led to the enactment of special legislation on the part of the state directed to the improvement of certain specific streams which had become badly polluted and were not adequately protected by the general laws. The first of these laws relates to the prevention of the pollution of the Neponset River, a small stream in the easterly part of the state which flows into Boston Harbor at the southerly boundary of the city of Boston. The condition of the Neponset River had been the subject of investigation by the State Board of Health in 1875 and again ten years later by the Massachusetts Drainage Commission, which had reported to the legislature plans for preventing the objectionable pollution of this stream. No action was taken by the legislature upon these recommendations, however, and the condition of the river was again the subject of investigation by the State Board of Health in 1890 and 1891, the results of which were also presented to the legislature.

Four years later the legislature directed a thorough investigation of the river and the condition of the Fowl Meadows, so called, an area of drowned

lands covering several square miles in the central portion of the watershed through which lay the course of the stream. This order was as follows:

> Resolved, That the state board of health be directed to investigate the sanitary condition of the meadows on the Neponset river and the beds, shores and waters of said river in the towns of Canton, Sharon, Norwood, Dedham, Milton and Hyde Park, and report whether their conditions are dangerous or injurious to the public health by reason of stagnant water or refuse from manufactories, or other causes. If said board shall find that the condition of the meadows or of the beds, shores or waters is dangerous or injurious to the public health, they shall recommend some plan for improving their sanitary condition and for the removal of any nuisance therefrom, and report the same to the next general court. The board may expend a sum not exceeding three thousand dollars in carrying out the provisions of this resolve.

Under this legislation, the river and the Fowl Meadows were examined and their condition described in a report to the Legislature in 1897. The causes of the pollution of the river in this case were the wastes from a large number of manufacturing establishments, chiefly paper mills, tanneries, woolen mills, etc., together with a small amount of sewage from town sewers and drains and from factories and dwellings.

In its report the board recommended the following measures for the removal of the conditions which were found to be injurious to health in the Neponset Valley:

> First.—Such additional legislation as will prevent the entrance into this stream of sewage and manufacturing wastes which have not been satisfactorily purified.
>
> Second.—The permanent removal of the flashboards of the dam of the Mattapan Mills, the enlargement of the cross-section of the river at points indicated on Plan No. 3, together with a deepening and reconstruction of the channel at such places as may be found necessary for making a channel of such width and grade as will prevent the flooding of the meadows during the times of high flows in late spring and summer.

The board also made the following further general recommendations relative to more effective measures for preventing the pollution of streams:

> . . . It is our opinion that all reasonable efforts have been exhausted in the attempt to do away with the remediable pollution of these waters, and that the time has come when the State must take more effective measures for the prevention of the pollution of the streams not now used as sources of domestic water supply, but still capable of injurious effect upon the public health.

These recommendations of the board, supported by petitions from the inhabitants of the valley, were considered by several successive legislatures and in 1902, five years after the report was presented, an act was passed authorizing and directing the board to prevent the pollution of these waters, but this act contained certain provisions which rendered it practically inoperative and no material progress was secured under it in preventing the pollution of the river. In the meantime, the condition of the stream grew worse and finally, in 1906, nine years after the plans for improving the river had been presented to the legislature, and specific recommendations

made for its improvement, the act of 1902 was amended and reduced to a more efficient form.

Under the interpretation of these laws by the law department of the Commonwealth, the board first gave notice to the cities, towns and others discharging pollution into the streams to discontinue such discharge unless the best practicable and reasonably available means were taken to render such waste or refuse harmless. The board then, under the provision of the act requiring it to consult with and advise the owners of factories either at their request or of its own motion as to the best practicable and reasonably available means of rendering their waste and refuse harmless, examined carefully all of the various wastes from each of the factories along the river and its tributaries and, where necessary, instituted experiments for the purpose of determining the best practicable method of purifying these wastes to such an extent that they would not produce objectionable conditions in the river. When the work was completed, the proprietor of each factory was advised as to methods which would render harmless the wastes therefrom and required to carry out the provisions of law.

The problem of purifying factory wastes, such as are found in this valley, is a very difficult one under the circumstances existing there. In some cases the factories are located in the midst of a rather dense population and areas suitable for disposal works cannot be secured in the neighborhood of the factory. In other cases, the construction of disposal works for the purification of such waste in the midst of a thickly-settled district would create a nuisance and other methods of disposal are necessary in such cases. Where a sewerage system exists in a city or town, it is practicable in some cases to admit such wastes to the sewers, but some of these wastes are of such a character as to interfere with the operation of the sewers or of sewage disposal works. Many of the works produce great quantities of waste, and as some of the works use, in dry seasons, nearly, if not quite, the whole flow of the river in their processes, it is necessary that the waste be treated in the neighborhood of the factory, in order that the water may be returned immediately to the river for the use of mills lower down the stream.

The results secured under these laws have not yet been such as to produce any marked improvement in the condition of the river which is offensive to sight and smell, in the drier part of the year throughout a large part of its course. Purification works have been begun at nearly all of the mills, and at a few of the mills all of the objectionable wastes are treated for the removal of objectionable matters, usually by sedimentation with subsequent filtration, or straining through sand, gravel, cinders or coke.

A large number of cases of pollution were long ago referred to the attorney-general, and in most of them action is still pending. Sewers or drains carrying sewage were found in two towns and these also were referred to the law department. In one of these cases the court postponed issuing a

decree in order to give the towns an opportunity to construct works and this opportunity was availed of so that no further action was necessary in that case. The other is still pending. A case against a manufacturer set down for a hearing early in the present year has been postponed to give the manufacturer further opportunity to make adequate provision for the purification of his waste liquors, which are large in amount and very objectionable. With the exception of one town, practically all domestic sewage has been removed from the river, and a manufacturing concern which recently began the discharge of sewage into the stream has been convicted in the courts. On account of the limitations of the act and the slow and cautious proceedings of the courts, the work of securing the necessary improvement of this river is slow and difficult, but by continued and persistent effort it is probable that an improvement in the condition of the river can be effected.

The other specific recommendation of the board—relating to the necessity of draining effectually the wet lands known as the Fowl Meadows—was considered by many successive legislatures, and finally in 1911 an act passed providing for carrying out the recommendations of the board and the necessary amount of money was appropriated for the purpose. This work will probably be completed in 1914.

Special Laws Relating to Other Streams.

Some time after the passage of the special law relating to the Neponset River, a similar law was passed by the legislature to provide for the improvement of the Aberjona River, a small stream lying in the northern part of the metropolitan area adjacent to Boston. The towns in the valley of this stream are all provided with extensive sewerage systems connected with the north Metropolitan sewerage works and all of the wastes are disposed of finally by discharging them through the Metropolitan system. The streams in this watershed are very small, however, and when the flow is low in summer they become at times seriously polluted by drainage from large quantities of tannery and other wastes deposited in their valleys and by leakage through the floors of tanneries and other establishments, which—instead of being discharged into the sewers—is allowed to flow into the streams. An enlargement of the sewerage system in this region is now being carried out, and it will probably not be difficult to prevent the pollution of these small water courses in the future.

A special law has also been enacted for the protection of that portion of the Charles River lying within the Metropolitan district, the act in this case also being similar to the Neponset River act, except that the State Board of Health is not authorized to proceed except upon petition from certain of the municipal authorities in the valley. The sewers are available in this valley also for the removal of the manufacturing waste in nearly all

cases, and the only action required thus far has been a notice to certain manufacturers as to the necessity for caring for their wastes in such a way as not to pollute the river.

Other Special Laws.

The only other stream which the legislature has thus far sought to improve by a specific law is the Blackstone River. The legislature of 1886, which passed the first important law relative to the prevention of the pollution of streams, adopted also a special act relative to the prevention of the pollution of the Blackstone River, an important clause of which is the following:

> . . . The city of Worcester shall, without being limited to any particular system, within four years after the passage of this act, remove from its sewage before it is discharged into the Blackstone River the offensive and polluting properties and substances therein, so that after its discharge into said river, either directly or through its tributaries, it shall not create a nuisance or endanger the public health. . . .

Action was taken in the courts by one of the towns in the valley below the city of Worcester many years ago to secure an improvement in the condition of the river which was at that time grossly polluted by the sewage of that city. The matter remained in the courts for many years and in the meantime the city of Worcester constructed various and extensive works for the purification of its sewage which included a chemical precipitation works and an area of 73 acres of sand filter beds, by which a part of the sewage is filtered and the remainder subjected to chemical precipitation.

The Blackstone River in more recent years has become seriously polluted in other parts of its course by manufacturing waste and by the drains in villages which have come to be used as sewers. Its condition is very objectionable and some further legislation is likely to be required before a material improvement can be effected.

Very important among the special laws relating to streams are those which in specific cases give authority to cities and towns to take and control the natural streams within their limits. Under such authority it is practicable for a city or town to deepen, straighten and improve the local water courses and maintain them in satisfactory condition, a difficult problem in thickly settled regions unless the channels are covered.

Local Laws Relative to Stream Pollution.

Many of the serious pollutions of the smaller streams and the local nuisances caused thereby occur within the limits of a single city or town and in such cases the powers of the local health authorities under Massachusetts laws are ample for the prevention of nuisances. In case of the neglect or refusal of a local board of health to take proper action relative to a nuisance, an appeal may be had to the county commissioners, but no appeal to the State Board of Health has been provided in such cases. Either party can,

however, request the advice of the State Board of Health as to proposed plans or measures for the removal of the objectionable conditions complained of, and confidence in the efficacy and reasonableness of the recommendations of the board has commonly secured the action necessary to relieve the nuisance. The right of appeal to the county commissioners is rarely used.

Actions at Law for the Prevention of the Pollution of Streams.

In a number of instances, especially where a manufacturer considers that his rights are infringed by the pollution of a river by a town or factory discharging waste into the stream above him, action has been brought in the courts to secure an injunction against the pollution of the river, and usually damages for the injury alleged to have been sustained.

Several such suits have been successful, and in discussing the question of stream pollution in one of its decisions, the Supreme Court made the following observations:

> The right to use the stream to carry away mere waste matter in a reasonable manner and to a reasonable extent is not so to be extended as to include a right to discharge into the stream noxious and deleterious matter to such an extent as sensibly and materially to foul the water and destroy its purity and fitness to be used by others.
>
> It is true of course that there is in any large body of water a purifying principle which will, either by ordinary sedimentary deposit or by chemical change, obviate the evil effects which otherwise would arise from the deposit therein of some limited amount of noxious matter. Accordingly it is not for every small deposit of such matter that the law will give a remedy. . . . There doubtless must be a material and sensible deterioration of the quality of the water. . . .

The Merrimack and Connecticut Rivers.

In all of the general laws relating to the prevention of the pollution of streams as originally enacted and as subsequently amended or codified, a special provision has been inserted that the requirements of the act were not to apply to the Merrimack and Connecticut Rivers, nor to so much of the Concord River as lies within the limits of the city of Lowell.

The Merrimack and Connecticut Rivers are the largest streams in the state and each of them receives much pollution from beyond its borders. In each case, also, large quantities of sewage were being discharged into the stream by the cities and towns along its banks in the course of its flow through the state, previous to the time when the laws relating to the prevention of the pollution of streams were first enacted.

The objectionable conditions of the Merrimack River arise almost entirely from two principal causes; one, the discharge into the river at Lawrence of an enormous quantity of waste from the process of wool scouring, and, two, the fouling of the banks of the river by sewage from the sewer

outlets of the large cities located along its banks, which discharge in most cases at the edge of the river bank at high water, whence the sewage flows across the exposed bottom of the stream in the summer season to the low-water channel, greatly fouling the banks and bed of the river, which are offensive at numerous places in these cities.

These conditions can be remedied without difficulty by the cities themselves if they choose to do so. Notwithstanding that the matter has been called to their attention frequently, they have failed thus far to provide proper outlets for their sewage. The new sewer outlets in these rivers, however, have been carried well out into the low-water channel and the offensive pollution of the banks of the river in these few cases avoided.

The Connecticut River has a drainage area nearly twice as great as the Merrimack where it passes out of Massachusetts, and the urban population of the Connecticut valley is much smaller than that of the Merrimack. In consequence, the dilution of the sewage is much greater. While much manufacturing waste is discharged into the Connecticut River, both within the state and in its upper waters before reaching the state, the condition of the bed, banks and waters of the river has not become objectionable at any point except in the neighborhood of some of the sewer outlets of the principal cities and towns, where the conditions are much the same as those already described in the cities of the Merrimack valley.

Much improvement has been made in recent years along the Connecticut River, many of the principal sewer outlets have been extended a distance of 200 to 300 feet into the stream, and the number of objectionable sewer outlets is few compared with the Merrimack valley. The sewers in the principal cities in the valleys of the Connecticut and Merrimack Rivers are nearly all constructed upon the combined plan and the complete removal of sewage from these rivers would require the introduction of separate systems of sewers in the greater part of nearly all of these cities. Circumstances have not become such as to require the treatment of the sewage of the cities and towns bordering these rivers as yet, though the problem of dealing with the sewage of cities along the Merrimack River may become a serious matter at no distant time.

Both of these rivers receive much pollution from manufacturing wastes in addition to the sewage, and in later years the condition of the Merrimack River has become seriously objectionable below the city of Lawrence and special legislation was secured in 1909 directing the State Board of Health to investigate and report upon the sanitary condition of the bed, banks and waters of this river, to ascertain whether it was in a condition injurious or dangerous to the public health or likely to become so, and, if so, to recommend plans for the removal of objectionable conditions. The board presented a report upon the matter to the legislature of 1909, and upon its recommendation this river was subjected to the same regulation as the

other streams of the state under the laws relating to the prevention of the pollution of streams.

Subsequently, under the further requirement of the legislature, the board continued the examination of this river and presented to the legislature of 1913 a detailed statement of the sources of pollution, together with plans for removing the most important of the pollutions of the stream and making such changes in the sewer outlets in the cities and towns along its banks as would prevent further objectionable conditions. This report was presented to the legislature of 1913 and referred to the committee on public health, which committee promptly reported no legislation necessary.

Summary.

In so far as the rivers of the state in general are concerned, the powers contained in the law of 1886, as amended in 1888, and supplemented later by the acts relating to sewer outlets and to the maintenance of sewage purification works, are the only general powers which have thus far been delegated by the legislature to the State Board of Health for the prevention of the pollution of streams and inland waters.

These laws are not mandatory except that they require the submission of plans to the State Board of Health for its advice, and no penalty is provided for neglect to observe them or carry out the recommendations that the board may make. Nevertheless, the recommendations of the board have almost invariably been followed, and the requirements of these laws very rarely evaded. The success that has attended the execution of these laws is attributed very largely to the course followed in carrying out their requirements. The board employed, from the beginning, physicians, engineers, chemists and other experts trained in this work and, aided by the results of thorough scientific investigations at Lawrence, was enabled to give reliable advice on questions relating to the purification of sewage and manufacturing waste and the measures necessary to prevent the objectionable pollution of streams. The reasonableness of its recommendations in the solution of practical problems quickly commended itself to the public and, taken as a whole, these acts have operated effectually and satisfactorily, with little friction, in the prevention of the objectionable pollution of inland waters in Massachusetts. Had they been in force at an earlier time and been applied to all of the inland waters of the State, the objectionable pollution of the streams by the sewage of cities and towns would to a large extent have been prevented.

The results of efforts to redeem the rivers which had already become badly polluted before the passage of these acts and to remove objectionable pollution not reached by those laws has been less satisfactory. In the cases in which the Legislature has been urged to interfere, action has often been avoided and in the most extreme cases where tardy action has finally been

taken, the limitations of the law and the cautious action of the courts have made progress under such laws extremely slow.

Nevertheless, progress is being made in the improvement of polluted rivers even under these circumstances, and there appears to be a growing recognition on the part of the authorities of cities and towns and the owners of factories of the demand that rivers shall not be used indiscriminately for the removal of sewage and foul waste to such an extent as to make them objectionable. But it is difficult to secure adequate laws for the relief of rivers already excessively polluted by the sewage of those cities and towns which will not voluntarily undertake the necessary improvement, unless there is evidence that the conditions are such as to be dangerous to the public health.

While at the present time there seems to be no danger that the desire for cleaner streams be carried too far or that experienced health authorities will attempt the application of impracticable standards to streams not used as sources of water supply, it is easily possible to go to extremes in this matter and, by attempting to apply unreasonable standards, to produce a reaction unfavorable to continued progress in the work of securing and maintaining cleaner streams.

It is important to recognize always the fact that it is impracticable to keep all pollution out of streams draining populous territories, especially regions containing numerous industries of the kinds which foul large quantities of water in their processes. The effluents from purification works alone, no matter how well conducted they may be, will inevitably cause some pollution of the streams, and the washings from streets, gardens, yards, factory grounds, etc., will contribute a further and by no means an insignificant quantity, as experience has shown in the valleys of rivers of considerable size, where thorough sewerage has made possible the complete removal of all sewage and objectionable manufacturing waste. Nevertheless, in some cases such streams are being maintained in such condition that they are not objectionable either to sight or smell. Their waters show upon analysis a much greater degree of pollution than those of rivers draining strictly agricultural regions, however populous, just as the waters of the latter are inferior in purity to those of the mountain streams, but their condition is unobjectionable for any reasonable present purpose, and they are not a menace to the public health.

In the efforts to prevent the pollution of streams and to do away with remediable pollution in cases where it has become objectionable, the results sought must be those which will secure the most effective sanitary improvement practicable for the inhabitants of the region affected, and the circumstances in each case must determine the course to be followed in regulating the use of the streams and inland waters as the ultimate places of disposal for sewage and manufacturing wastes.

SEWAGE DISPOSAL AND STREAM POLLUTION IN MINNESOTA.

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Read before the Sanitary Engineering Section, American Public Health Association, Colorado Springs, September, 1913.

The population of the state of Minnesota is largely rural, for less than one half of the population reside in communities of four hundred and over.

In Table I the communities of the state are divided into five classes according to population, all communities of four hundred population or over being included. Thirty-nine per cent. of these communities have sewerage systems and a little over 11 per cent. have sewage disposal plants.

TABLE I.

Population.	No. of communities.	Aggregate population.	No. having sewerage.	Sewage disposal plants.
Over 3,000	39	831,068	38 or 97%	
2,000–3,000	26	61,183	16 " 62%	
1,500–2,000	30	40,063	12 " 40%	
1,000–1,500	50	58,755	20 " 40%	
400–1,000	120	82,093	20 " 17%	
	265	1,083,100	106 or 39%	28 or 11%

The state law in regard to the pollution of streams is as follows:

Sec. 2147. No sewage or other matter that will impair the healthfulness of water shall be deposited where it will fall or drain into any pond or stream used as a source of water supply for domestic use. The State Board of Health shall have general charge of all springs, wells, ponds, and streams so used, and shall take all necessary and proper steps to preserve the same from such pollution as may endanger the public health. In case of violation of any of the provisions of this section, the State Board may, with or without a hearing, order any person to desist from causing such pollution, and to comply with such direction of the Board as it may deem proper and expedient in the premises. Such order shall be served forthwith upon the person found to have violated such provisions.

Sec. 2131. The State Board of Health may adopt, alter and enforce reasonable regulations of permanent application throughout the whole or any part of the state for the preservation of the public health. Upon the approval of the attorney general, and the due publication thereof, such regulations shall have the force of law, except in so far as they may conflict with a statute or with the charter or ordinances of cities of the first class upon the same subject. In and by the same, the board may control by requiring the taking out of licenses or permits or by any other appropriate means, any of the following matters: . . . 5. The pollution of streams and other waters, and the distribution of water by private persons for drinking or domestic use.

There are nineteen communities, with a total population of 147,000, which violate the law in regard to the pollution of streams used as domestic water supplies.

There are eleven cities, with a total population of 430,000, which are adversely affected by this municipal pollution of water and of these eleven, eight are among the nineteen polluters and contain 89 per cent. of the population of the polluting cities.

Of these twelve cities taking their water supply from streams polluted by municipal sewage, ten are protected by some water purification process and two are unprotected. The population of these two unprotected cities is equivalent to 5 per cent. of the total population of the cities affected, and equivalent to three tenths of 1 per. cent of the population of the state. The polluting cities are given in Table II and the cities affected by pollution are given in Table III.

Of the twenty-eight sewage disposal works in the state, seven are located on streams used below for municipal water supply and may be considered as having been built in an attempt to comply with the law, although in the cases of only two of them would it be possible to operate the plant so that the water supply would not be polluted. The other twenty-one sewage purification plants are located on small streams or lakes not used for domestic purposes and their ostensible purpose, therefore, is to prevent a local nuisance.

TABLE II.

City.	Populations.	Disposal.
Brainerd	8,526	No plant
Little Falls	6,078	"
St. Cloud	10,600	"
Anoka	3,972	"
Cambridge	900	"
Milaca	1,102	"
Princeton	1,555	"
Fergus Falls	6,692	"
Crookston	7,559	"
Montevideo	3,056	"
Two Harbors	4,990	Septic tank
Duluth	78,446	No plant
Thief River Falls	3,714	Imhoff tank
Red Lake Falls	1,757	No plant
Breckenridge	1,840	"
Grand Rapids	2,230	"
Monticello	858	"
Ely	3,572	Imhoff tank
	147,447	

City.	Population.	Type of plant.	Date installed.	Operated now.	Why Installed.		
					Protect water supply.	Protect another city's w. s.	Abate a nuisance.
Ada	1,432	Screen	1910	Yes			Yes
Alexandria	3,001	Septic tank	1910	Yes			Yes
Anoka Asylum	800	Imhoff tank	1912	Yes		Yes	
Baudette	897	Septic tank	1909	Yes			Yes
Bemidji	5,099	Septic tank	1911	Yes			Yes
Bovey	1,377	Septic tank	1907	No inf.			Yes
Canby	1,528	Septic tank	1910	Yes			Yes
Coleraine	1,613	2 septic tanks	1909	No inf.			Yes
Detroit	2,807	Septic tank	1909	Yes			Yes
Elbow Lake	776	Septic tank	1908	No inf.			
Ely	3,572	Imhoff tank	1911	Yes			Yes
Fairmont	2,958	Septic tank and sand fil.	1906	Yes No			Yes
Gilbert	1,700	Imhoff tank and percol. fil.	1911	Yes			Yes
Glenwood	2,161	Septic tank	1904	No inf.			Yes
Hallock	910	Septic tank	1907	Yes			Yes
Litchfield	2,333	Imhoff tank	1912				Yes
Morris	1,685	Septic tank	1906	Yes			Yes
Pipestone	2,475	Septic tank and percol. fil.	1907 1908	Yes			Yes
Two Harbors	4,990	Septic tank	1907	No	Yes		
Warren	1,613	Septic tank	1910	Yes			Yes
Waseca	3,054	2 sep. tanks	1907	No inf.			Yes
Willmar	4,135	Imhoff tank	1913				Yes
Willmar Hospital		Imhoff tank and percol. fil.	1912	Yes			Yes

City.	Sewage discharged into.	Char. of sewage predominating.	Dist. sewer outlet to water intake.	Source of water supply.
Ada	Wild Rice River	Domestic	100 miles	
Alexandria	Lake Agnes			Well
Anoka Asylum	Rum River		15 miles	Tubular well
Baudette	Baudette River		¼ mile	Rainy River
Bemidji	Mississippi			Tubular well
Bovey	Trout lake			"
Canby	Florida creek			"
Coleraine	Trout Lake			Mine drift
Detroit	Lake St. Clair			Detroit Lake
Elbow Lake				
Ely	Shagwa lake		1 mile	Shagwa lake
Fairmont	Lake George			Budd lake
Gilbert	Embarrass River			Genoa mine
Glenwood	Lake Minnewaska			Springs
Hallock	Two Rivers			Two Rivers
Litchfield	Crow River			Tubular well
Morris	Pomme de Terre R.			"
Pipestone	Dry run			"
Two Harbors	Lake Superior		½ mile	Lake Superior
Warren	Snake River			
Waseca	Slough			Tubular well
Willmar	Drainage ditch			"
Willmar Hospital	Foot lake			"

TABLE III.

City.	Population.	Protection.
St. Cloud	10,600	Hypochlorite
Little Falls	6,078	"
Brainerd	8,526	"
Minneapolis	301,408	Filter and hypo.
Breckenridge	1,840	" "
Ely	3,572	" "
Granite Falls	1,454	Not protected Water little used
Two Harbors	4,990	Hypochlorite
Duluth	78,446	"
Crookston	7,559	"
E. Grand Forks	2,533	Filter and hypo.
Moorhead	4,840	Not protected
	429,772	

From the tables it is apparent, therefore, that the problem of stream pollution in its relation to public health as distinct from the question of decency is limited to a comparatively few communities and to a small portion of the population of the state. There are many communities which should have sewerage systems and sewage disposal plants which do not have them. There is no doubt of the great value from a public health standpoint of a sewerage system, and a sewage disposal plant may be considered as an adjunct to the sewerage system and in that way, in Minnesota, an agency for the benefit of the public health, but by itself, it has value in Minnesota chiefly as a means of preventing a nuisance.

PRESENT STATUS OF WATERWAYS SANITATION IN MONTANA.

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Read before the Sanitary Engineering Section, American Public Health Association, Colorado Springs, September, 1913.

There are still many mountain streams in Montana that are practically in their natural state of purity above human habitation. Many city water supplies are taken from such streams. In some cases the cities control the watersheds and are able to effectively prevent undue contamination. In other instances more attention should be given to sanitary conditions on the water sheds. Some of the more important city supplies taken from mountain streams are listed below: Anaconda, Butte, Bozeman, Bellgrolle, Deer Lodge, Missoula, Dillon, Helena, Hamilton, Red Lodge, Stevensville, etc.

A mountain stream soon becomes contaminated to a greater or less degree as it flows through an inhabited valley. The most important rivers in the state are: the Yellowstone, Missouri, Milk, Deer Lodge, Missoula, and Bitter Root.

All of these rivers receive untreated city sewage and contamination from the watersheds. Waste irrigation water returning to the rivers is an important factor in contaminating waterways in Montana.

There are no streams in Montana that are so highly contaminated as to create a nuisance.

Analyses, sanitary inspections and health statistics show that only in a few places on any of these rivers should water be taken for city use without purification.

None of these rivers are contaminated at present by city sewage to the extent that an undue burden would be put on water purification plants, erected for treating water for domestic use.

In many instances the sanitary conditions of the watersheds would make it desirable to purify surface waters before use, even if no city sewage were delivered to the streams. This condition arises from the contamination deposited on the watersheds near the streams from passenger trains and also because of the return of waste irrigating water to the streams.

People in many portions of the state depend on surface water supplies because ground waters are frequently highly charged with mineral salts. This condition makes it necessary sometimes to use questionable surface waters.

THE STATUS OF STREAM POLLUTION AND SEWAGE TREATMENT IN OHIO.

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Read before the Sanitary Engineering Section, American Public Health Association, Colorado Springs, September, 1913.

In presenting the present status of stream pollution and sewage treatment in Ohio, it will be my aim to briefly discuss the legislation which has been enacted to prevent stream pollution; the existing cases of stream pollution in the state; the development of sewage treatment plants; and the difficulties which are encountered in preventing and correcting the pollution of streams.

Legislation.

In the state of Ohio legislation directed against the pollution of streams has been quite progressive, and at the present time laws exist which make it possible to prevent and correct conditions which cause streams to become unsightly, odorous and unhealthful.

In 1893 the legislature of the state of Ohio passed a bill (Sec. 1240, General Code of Ohio) providing that no public water supply or sewerage system or purification works for a water supply or sewage shall be installed until the plans have been submitted to and approved by the State Board of Health. A penalty of not less than $100 nor more than $500 is attached for violation of the provisions of this section.

This law has been an important factor in the prevention of stream pollution and in insuring that water supplies of good quality be installed. It, however, fails to supply a remedy for the pollution of streams resulting from sewage discharged through outlets installed prior to 1893. In 1908 the so-called Bense Act (Sec. 1249–1261, General Code of Ohio) was passed, which gives the State Board of Health power to order the installation of water purification plants and sewage treatment works after due investigation has demonstrated their necessity. The passage of this act has furnished means whereby stream pollution, resulting from sewage and other wastes discharged through municipal sewers, or from manufacturing plants, may be corrected. This law was thoown into litigation soon after its passage and did not become fully effective until April, 1912, when the Supreme Court decided its constitutionality.

Small buildings, private institutions, hospitals, and the like, cause minor sewage pollution and create local nuisances. To bring about a correction of these conditions, a section of the Ohio Building Code, passed in 1911,

regulates the disposal of wastes and provides that plans for sewage treatment plants for such buildings shall be approved by the State Board of Health.

Numerous cases of serious stream pollution have occurred in the outskirts of the larger cities of the state, due to the absence of sewers immediately within the city and the inability of any authority to build sanitary sewers outside the city. In 1913 a bill was passed providing that the county commissioners of any county may establish sewer districts within three miles of any municipality. Furthermore, the State Board of Health may, upon investigation, order the installation of sewers and sewage treatment works in such districts. In cases where the district naturally forms a drainage area in which a portion of a municipality is included, coöperation between the county and municipality is permitted.

Stream Pollution.

Before describing the conditions of stream pollution and sewage treatment in Ohio, it may be well to give a brief description of the state as a whole. The divide between the watershed of the Great Lakes and the Ohio River crosses the northerly portion of the state of Ohio. The area north of the divide, including the islands in Lake Erie, is tributary to Lake Erie and comprises about 30 per cent. of the total area of the state. It is drained by a number of streams, the largest of which is the Maumee River, with a watershed area of about 6,600 square miles, 4,580 square miles of which are in Ohio. Of the other streams traversing this area, only one, the Sandusky River, has a watershed area of more than 1,000 square miles. The rivers of Ohio, tributary to Lake Erie, are the Maumee, Portage, Sandusky, Huron, Vermilion, Black, Rocky, Cuyahoga, Chagrin, and Grand. The topography of this section of the state is generally flat with a moderate slope toward the lake. The streams follow a general northerly direction. The area south of the divide comprises 70 per cent. of the state and is naturally subdivided into five principal drainage areas, all tributary to the Ohio River. The principal streams of this portion of the state are the Mahoning (a tributary of the Beaver River), Muskingum, Hocking, Scioto, Little Miami, and Great Miami Rivers.

Having in mind a general conception of the drainage features of the state, it may be well to review briefly the conditions existing in each drainage area. We shall first consider that portion of the state tributary to Lake Erie. With the exception of the Maumee River, the streams on this area are so small that, with any considerable urban population, excessive pollution would be inevitable without sewage treatment plants. As it happens, the principal cities of this section of the state are at or near the mouths of the rivers or on Lake Erie, and consequently the greatest pollution occurs at

these points. The Maumee and Cuyahoga watersheds are the only ones which have important cities located above the mouths of the rivers.

The Maumee River itself is at no point polluted to an extent to give rise to a nuisance. Its tributaries, however, receive serious pollution at various points. At Toledo, Swan Creek and Ten Mile Creek are notoriously polluted. At Lima, the Ottawa River is rendered very offensive. At Findlay, the Blanchard River is visibly polluted. At Wapakoneta, the Auglaize River is rendered offensive during periods of low flow. At Van Wert, a county ditch is converted into an open sewer. At Bryan, manufacturing wastes pollute a small ditch. At Wauseon, the wastes from a condensary pollute Turkey Foot Creek, and at Paulding, Flat Rock Creek is seriously contaminated by the wastes from a beet sugar factory. Plans are in preparation for the improvement of conditions at Toledo, Lima, and Wapakoneta, and plans have been prepared to correct the pollution at Bryan.

The Portage River is at no point visibly polluted by sewage. Small tributaries at Fostoria and Bowling Green are, however, rendered very offensive. Steps have been taken to correct the conditions at Fostoria by the reconstruction of the existing sewage treatment plant installed in 1896, and at Bowling Green the conditions will probably be improved within a few years. The Sandusky River is seriously polluted at only one point, immediately below Bucyrus. The State Board of Health has ordered the installation of a sewage treatment plant at this point and plans are in preparation.

No case of stream pollution exists on the Huron River watershed except at Norwalk, where Norwalk Creek and the east fork of the Huron River are contaminated by sewage. Plans for a sewage treatment plant for this city have been prepared. The Vermilion, Black and Rocky Rivers are not seriously polluted at any point above their mouths. The sewage from Lorain causes some pollution of the Black River at its point of discharge into Lake Erie and the Rocky River is polluted to a slight extent by sewage from the city of Lakewood located at its mouth. The Little Cuyahoga River below Akron is seriously polluted by the sewage from the city. The State Board of Health has ordered the installation of a sewage treatment plant at Akron and plans are being prepared. The Cuyahoga River at Cleveland has for a number of years been rendered extremely offensive by the sewage from about one half of the city. The State Board of Health has ordered the abatement of these conditions and studies leading to the installation of treatment works are being made. The Chagrin River is not seriously polluted at any point. The Grand River is rendered unsightly and offensive by the wastes from chemical works located near its mouth.

Lake Erie itself is polluted by the sewage from Cleveland, Toledo, Lorain, Sandusky, Ashtabula and Conneaut. The evidence of this pollu-

tion exists in the harbors, at the mouths of the rivers, and as far upstream as slack water extends. At Cleveland, visible pollution has been noted in the vicinity of the outlet of the main intercepting sewer discharging into Lake Erie.

We shall next consider that portion of the state tributary to the Ohio River. The Mahoning River is polluted by the sewage from Warren, Niles, and Youngstown, which cities are contiguous along the stream a short distance above the point where it leaves Ohio and enters Pennsylvania. Plans for sewage treatment for Niles and Warren have been prepared.

The Muskingum River is not visibly polluted by sewage. Several of its tributaries, however, are rendered offensive. The principal cases of stream pollution are at Cambridge, where Wills Creek is contaminated by the sewage from the city and by acid iron wastes; at Canton, where Nimishillen Creek becomes a nuisance during low flow; at Massillon, where the Tuscarawas River is somewhat polluted; at Barberton, where Wolf Creek and the Tuscarawas River receive sewage and manufacturing wastes in an amount to create a nuisance; and at Dennison and Uhrichsville, where Stillwater Creek is rendered very offensive. Canton has been ordered by the State Board of Health to abate the existing nuisance in Nimishillen Creek and plans are being prepared. Steps are also being taken by the State Board of Health to bring about an improvement in the disposal of sewage at the other points mentioned.

The Scioto River receives sewage pollution near its headwaters from the cities of Kenton and Marion, and other cases of serious pollution exist at Delaware, where the Olentangy River is contaminated, at Marysville where Mill Creek is polluted, and at Washington C. H., where Paint Creek is rendered very offensive. Plans for a sewage treatment plant for the last mentioned city have been prepared and a plant is being installed at Marysville. A tributary of the Little Miami River receives sewage from Xenia and is polluted to a greater extent than any other stream on this watershed. Turtle Creek below the village of Lebanon is also seriously polluted. The State Board of Health is now considering the advisability of ordering the abatement of these conditions. Although the Great Miami River watershed is rather densely populated and has a number of important cities, there exists no case of serious stream pollution. This is due to the fact that the large communities are located in the valleys and upon the principal streams of this drainage area.

Upon that area which is tributary directly or through minor streams to the Ohio River there is only one instance of serious stream pollution, namely, in Mill Creek, which passes through the city of Cincinnati and receives large volumes of sewage and manufacturing wastes. This stream is one of the most polluted water courses within the state and although the

nuisance has existed for a number of years, it has only been recently that that definite plans for the abatement of the conditions have been prepared.

In the above brief discussion thirty-one cases of stream pollution in Ohio are mentioned. Plans for the correction of eight of these cases have been prepared and the State Board of Health has ordered improvements in six other cases. Attention is being given to the conditions existing in thirteen of the cases mentioned, and the municipalities have been advised of the necessary improvements. Orders may be issued by the board in the near future to correct the conditions in several of these cases.

Sewage Treatment.

The first sewage treatment plant in Ohio was installed at Canton in 1893. In accordance with accepted practice at that time chemical precipitation tanks were provided. Two years afterwards a similar plant was installed at Alliance, but since that time no plant of this type has been installed in Ohio. The first plant utilizing intermittent sand filtration as a final process was installed in Oberlin in 1894 and since that date the use of this type of plant has been general. The first plant, including contact filters, was installed at Lakewood in 1901 and its operation was attended with such great success that a number of plants of this type have been installed in other cities. The first plant employing sprinkling filters as a device was installed at Medina in 1906 and two years later the Columbus plant was installed.

Since 1893 the number of municipal sewage treatment plants in Ohio has increased to fifty and the population of the communities served from 27,500 to 485,000. Of the forty-six municipal plants, installed prior to 1913, twenty-five have intermittent sand filters as a final treatment device and sixteen include contact filters in the process of treatment. Only three sprinkling filter plants have been installed, but these serve a greater population than any other type of plant, due to the use of this type of plant at Columbus.

Of the forty-six plants, thirty-one were provided to comply with orders or advice of the State Board of Health, and the others were installed voluntarily on the part of the municipality or to prevent damage suits. Relative to the condition of the plants, thirty-one may be said to be in good condition, ten inadequate, and five inefficient. Plans for improvement of three of the ten plants which are inadequate have been prepared, and the State Board of Health will probably order the improvement and enlargement of two other plants which are at present useless. The five plants which are inefficient have become so through neglect of their regular operation.

Sewage treatment plants for public and private institutions have been installed at various times since 1896. Up to the present year thirty-six plants have been installed or are in progress of construction, and the population served is about 18,000. Of the thirty-two plants which had been

installed prior to 1913, twenty-seven employ intermittent sand filters as a final process of treatment. Other types represented are tanks alone, tanks and contact filters, and tanks and coarse grain filters.

At the present time a remarkable development in sewage treatment in Ohio is in prospect. Cleveland, Toledo, Akron, Canton, Lima, and Sandusky, cities ranging in population from 20,000 to 625,000, are engaged in studying their sewage disposal problems with a view to installing sewage treatment plants to avoid excessive pollution of streams. In addition, plants are in prospect in nineteen other smaller cities and villages of the state. The population represented by the twenty-five municipalities for which plans have been prepared or are in preparation for sewage treatment plants is 1,100,000, which is over twice the population at present served by the sewage treatment plants of the state. We may reasonably expect that within ten years the sewage from the principal cities of the state will receive treatment before it is discharged into streams.

Difficulties Encountered in the Prevention and Correction of Stream Pollution.

In the prevention and correction of stream pollution, the State Board of Health experiences considerable difficulty. The cities of the state seem to be entirely willing to coöperate in correcting stream pollution and the board has been very successful in securing the establishment of sewage treatment plants in cases where stream pollution exists, as well as in those cases where cities propose the establishment of new sewer systems. The question is frequently submitted to the board, however, to determine the required degree of treatment which the sewage from any particular municipality should receive. While this is essentially a question to be decided by a consulting engineer employed by the city, nevertheless, inasmuch as the State Board of Health is the final authority, the question may logically be submitted to that body. Our knowledge of the flow of streams in Ohio is very limited, inasmuch as no comprehensive measurements of stream discharge have been made. We must rely upon estimates which are at best rough approximations. The fundamental consideration to be given in determining upon the required degree of treatment of sewage to avoid nuisance is the dilution afforded by the volume of flow of the stream. Efforts are now being made to secure means whereby comprehensive stream flow measurements can be made in various portions of the state.

One of the most important difficulties encountered in preventing stream pollution is the failure to secure proper operation of the sewage treatment plants after they are installed. This is of course general throughout the country and is not peculiar to Ohio. Concerted efforts have been made by the State Board of Health to improve the operation of existing plants and in some cases good results have been obtained. The neglect of sewage

treatment plants has been so forcibly brought to the attention of the State Board of Health that an attitude has been adopted to bring about the installation of plants of as simple a type as is possible to obtain the results required. Thus where the flow of a stream is sufficient to avoid nuisance and no water supply is endangered, tank treatment would be preferred to more refined methods, especially in the smaller communities.

Improved legislation which would give the State Board of Health the power to prevent the discharge of manufacturing wastes into streams by making it necessary that plans for treatment of the wastes be submitted before a manufacturing plant is established, would do much to simplify the problem of stream pollution. In many cases plants contribute liquid wastes which pollute streams more seriously than the sewage from cities and great difficulty is experienced in securing an improvement.

In conclusion the magnitude of the problems associated with the prevention and correction of stream pollution in Ohio is recognized by state and municipal authorities. Progressive legislation, giving considerable discretionary power to the State Board of Health, has been the principal factor in bringing about needed improvements. In addition to its actual enforcement of the law the State Board of Health has secured improvements in numerous cases by giving to municipalities general advice relative to the prevention of stream pollution.

The large number of sewage treatment plants in existence and in prospect testifies the coöperation which is being secured between the health department of the state and the various municipalities. The present activity in the large cities of the state encourages one in the belief that improved disposal of sewage for those cities will be realized within a few years.

The lack of certain fundamental data necessary in the solution of stream pollution problems, particularly thorough knowledge of the volume of discharge of streams, introduces a serious difficulty in the administrative work of the State Board of Health. It is intended to obtain comprehensive stream flow measurements as soon as funds for this purpose can be secured. The neglect of the operation of sewage treatment plants is also a serious detriment to a broad solution of stream pollution problems. It is difficult to correct the tendency upon the part of municipal authorities to treat with indifference the work connected with sewage disposal and in many cases it is only by frequent inspections on the part of a central authority that satisfactory operation of plants can be secured.

CONDITIONS IN VIRGINIA WITH RESPECT TO STREAM POLLUTION.

RICHARD G. MESSER, C. E.,
State Sanitary Engineer.

Read before the Sanitary Engineering Section, American Public Health Association, Colorado Springs, September, 1913.

So far the subject of stream pollution in the state of Virginia has received very little attention and, except in one or two instances mentioned later, no data of importance have been collected for the purpose of showing the degree of pollution of the different streams.

At the present time there are no special laws in this state giving the Board of Health authority to make regulations in regard to the disposal or treatment of sewage and trade wastes. Individuals or communities must base their claims for damages on previous decisions defining the rights of riparian owners as determined in the courts of common law. These decisions refer for the most part to the excessive pollution of small streams where the waters are rendered unfit for agricultural uses and do not as a rule apply to the larger rivers under discussion.

There are in Virginia only two towns maintaining plants for the treatment of sewage: Winchester, having a population of 6,000, and Colonial Beach, a summer resort, which has a winter population of about 1,000 and a summer population estimated 12,000 to 15,000. Several towns in accordance with recommendations made by the board have under consideration the installation of treating plants. Disposal by dilution has been in the past and in all probability will continue to be for a number of years the general method.

It is the opinion of the writer that the time has not arrived in this state to urge artificial treatment of sewage with the object of maintaining a high standard of purity of the larger rivers except in some special cases. The statistics on the next page as to conditions will explain why the subject has not assumed the importance here that it has in many other states.

It will be noted that there are only eighteen places having a population exceeding 5,000, and that the total for these is only 20.8 per cent. of the population of the state.

Furthermore, most of the larger cities and towns are situated in the eastern part of the state from which the sewage is discharged into the Chesapeake Bay or into the James, York, Rappahannock and Potomac at tide level.

STATE OF VIRGINIA.

Total area in square miles	40,125
Drainage areas	12
Total population (1910)	2,061,612

TABLE SHOWING DISTRIBUTION OF TOTAL POPULATION.

Population (1910).	Number of places.	Total population.	Per cent. of state total.
Above 100,000	1	127,628	6.1%
50,000–100,000	1	67,462	3.2
10,000–50,000	8	186,843	9.0
5,000–10,000	8	52,890	2.5
1,000–5,000	57	116,374	5.6
Total above 1,000			26.4%
Rural population			73.6

The following table gives the classification by population of places discharging sewage into tidal waters:

Population, 1910.	Number of places.	Total.	Per cent. of state total.
Above 50,000	2	195,190	9.3
10,000–50,000	4	92,851	4.5
5,000–10,000	4	23,387	1.1
1,000–5,000	7	13,460	0.6
			15.5

The principal facts brought out by the two tabulations above are:

1. Virginia has a large rural population about 73.6 per cent.

2. That of the remainder, sewage from 15.5 per cent. is discharged into large rivers at tide level or directly into Chesapeake Bay.

3. That only 10.9 per cent. of the population in places exceeding 1,000 contribute to the pollution of the twelve principal streams.

The special cases referred to which are now under investigation are:

1. The pollution of James River by trade wastes. The James has a drainage area of about 9,700 square miles and a length of about 335 miles. The principal cause of complaint is due to the discharge of sulphite waste liquors from the mills at Covington. The dark discoloration caused by these sulphite wastes is often noticeable as far down as Richmond, a distance of 250 miles. Attempts to have a law passed to regulate the disposal of manufacturing wastes have been defeated by the interests affected.

2. The pollution of valuable oyster grounds near Hampton Roads and along the Potomac River. Several cities and towns have under consideration the purification of sewage as a result of investigations and recommendations made by the State Board of Health.

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THE NEW YORK PUBLIC HEALTH LAW.

Our readers will remember that the Public Health Law of New York State enacted in 1913 introduced two new and exceedingly promising features into State sanitary legislation. The power to establish a sanitary code for the entire State outside of New York City was vested in the hands of a Public Health Council of seven members; while the administration of this code and of the general Public Health Law of the State by the locally appointed health officials was placed under the general supervision of the

State Commissioner of Health with twenty District Sanitary Supervisors acting as intermediaries.

The first fruits of the work of the Public Health Council are now at hand in the shape of Chapters I and II of the Sanitary Code dealing respectively with Definitions and General Provisions and with Communicable Diseases. This really notable sanitary document embodies the most recent advances of public health science more completely than any similar set of regulations with which we are acquainted and offers convincing evidence of the wisdom of delegating powers of this sort to a small and expert body. The same principle of ordinance-framing by a small board is, of course, in force in most well-organized cities, but is a novelty in State health legislation.

Twenty-four diseases are listed as communicable, including, besides those which are reported everywhere, anthrax, dysentery (amœbic and bacillary), epidemic or streptococcus (septic) sore throat, German measles, ophthalmia neonatorum, paratyphoid, poliomyelitis, puerperal septicæmia and trachoma. On the other hand, cancer and pneumonia, which are reportable in some states and cities but which are not practically amenable to control by isolation are wisely omitted.

Physicians are required to report these diseases to the local health officers within twenty-four hours, the report to be by telephone or telegram when practicable and also in writing. Superintendents of hospitals, other institutions or dispensaries, teachers and school principals, proprietors or keepers of hotels, boarding or lodging houses, visiting nurses and public health nurses, persons in charge of labor or other camps, masters or persons in charge of vessels and persons in charge of farms or dairies, all have specific duties as to reporting laid upon them.

The sections of the Code prescribing how the diseases are to be handled after reporting are noteworthy for the clearness with which they emphasize the modern view that persons rather than things are the usual conveyors of infection, and the consequent stress upon individual isolation and the care of excreta rather than the vague gunshot quarantine of earlier days. In any disease except smallpox, if the person affected is properly isolated, other adult members of the family may continue their usual vocations, provided such vocations do not bring them into close contact with children. Terminal disinfection is required as a rule only "when deemed necessary by the local health officer" and appears along with Cleansing and Renovation as one of the three procedures which may be used separately or in combination at his discretion.

On the other hand, the rules governing the patient himself—the really dangerous factor—are correspondingly rigorous. The physician in charge is required on his first visit to give to the nurse or other person in attendance detailed instructions, conforming to the special rules and regulations of the

State Department of Health in regard to the disinfection and disposal of excreta in cholera, dysentery, paratyphoid fever and typhoid fever, and of the discharges from the nose, mouth and ears in diphtheria, cerebrospinal meningitis, epidemic or septic sore throat, measles, poliomyelitis, scarlet fever, smallpox and whooping cough. The local Health Officer is required to post the usual placards in cases of diphtheria, epidemic cerebrospinal meningitis, measles, poliomyelitis, scarlet fever, smallpox and typhus fever, and to furnish special circulars of information in these diseases and in epidemic or septic sore throat, typhoid fever and whooping cough as well. He must require proper isolation or removal to a hospital and may quarantine the entire household if neither of these alternatives is possible. The exposure of children and minors to diphtheria, measles, scarlet fever, smallpox, typhus fever or whooping cough is specifically prohibited, and children suffering from communicable disease or inmates of households which have been affected within fifteen days are to be excluded from schools and public and private gatherings. Minimum periods of isolation from persons suffering from the principal diseases are specified in the Code with maximum periods of incubation for those exposed, but the prolongation of isolation during convalescence and the shortening of isolation of exposed persons is left to the judgment of the local authority. A special section provides for the disinfection of the persons of patient and attendants throughout the course of the disease and at its close.

The State Department of Health is given power to formulate special rules and regulations for controlling carriers in cholera, bacillary dysentery, diphtheria, epidemic cerebrospinal meningitis, poliomyelitis and typhoid fever.

The sale of milk or other foods handled by or in any way exposed to persons affected with communicable disease is regulated by rigid ordinances.

The Public Health Council has power to amend this Code at any time it sees fit to do so, and no doubt additions and improvements will be made from time to time. Taken all in all, however, these sections so far established constitute an admirably progressive and rational formulation of the essential principles of present day sanitary science, so far as the control of communicable diseases is concerned. They have recently been published as Special Bulletin No. 2 of the New York State Department of Health, together with detailed regulations as to Cleansing and Disinfection during and after Communicable Disease. Both these sections of the Code and the Regulations are worthy of the careful study of city and State Health Officers the country over.

PULMONARY ANTHRACOSIS*—A COMMUNITY DISEASE.

OSKAR KLOTZ.
From the Pathological Laboratories, University of Pittsburgh, Pittsburgh, Pa.

Definite observations upon the presence and nature of pigment within the lung substance and its associated lymphatic structures are of relatively recent date. Nevertheless, as early as 1717, Ramazzini discussed the presence of carbonaceous material within the lung and indicated an association with definite pulmonary diseases. His observations were made upon various laborers who, through the inhalation of angular stone particles, became predisposed to asthma and tuberculosis. His observations, however, did not suggest that any of the foreign material contained within the lung, consisted of a carbon deposit.

Not until Pearson in 1813 studied the problem and applied the term anthracosis or coal miner's lung, followed by a report by Laennec in 1819, was a more acute attention attracted to the subject. Pearson indicated that individual coal particles when inhaled became deposited in the lung tissue and upon the accumulation of larger quantities of this pigment, the lung gave macroscopic evidence of its presence.

This contention was further supported by Gregory, who in 1831, described the pigment in the lungs of a coal miner, with definite tissue changes within the organ. Other English authors (Thompson, Simpson, and Stratton) made similar observations and indicated the importance of anthracotic deposits as a type of occupational disease.

Although Pearson's views were accepted in England, they were strongly combatted in Germany, particularly by Koschlakoff, as well as by Virchow and Henele who regarded the coloring matter in the lung substance and in the lymph nodes of haematogenous origin. Virchow did not believe that the lung substance could be penetrated by inert foreign particles. As late as 1855, Barthelmess discussed "pulmonary melanosis" as a progressive pigmentation of the lung resulting from repeated hæmorrhages and inflammation. Subsequently, however, Pearson's observations were confirmed in Traube's clinic (1860) where some carbon pigment, presumably having its origin from charcoal, was demonstrated in the lung substance. Since then the deposition of carbon from smoke has been amply confirmed by studies upon human lungs as well as by animal experimentation. The first confirmatory animal experiments were carried out by Knauff (1867) and repeated by Konradi (1869).

* This research was carried on in conjunction with the "Smoke Investigation" of the Department of Industrial Research, University of Pittsburgh.

In the earlier discussion upon the inhalation of dust, including the carbon particles of smoke, it was indicated that as every one inhaled more or less of it during his life time, little pathological change, other than the storage of pigment, occurred in the lung tissue. It was, however, recognized that the inhalation of different foreign substances had a varying effect upon the respiratory organs. It was deemed that carbon pigment had the least harmful effect and hence, the deposits which were found in the adult lungs, could be disregarded as having any association with respiratory diseases or clinical symptoms during life.

With the admission that the black pigmentation of the lung was the result of the inhalation of carbon particles contained in the air, a considerable controversy began concerning the manner in which the foreign material made its entrance into the tissues. It was not uncommonly observed that the sputum of individuals working in smoky atmospheres would, for considerable periods of time, contain black pigment particles. Some of this foreign material was free, while some was contained within cells. Knauff believed that these cells were desquamated epithelial structures of the bronchi, which had lost their cilia. It was thought that with the active desquamation of the epithelial lining that a more ready access for the pigment to the deeper structures was possible. Sikorsky and Klein both believed that foreign particles were able to pass between the uninjured epithelial cells and directly enter the lymphatics.

On the other hand, Arnold and Schottelius opposed the view of the direct migration of the pigment into the tissues and claimed that the transport was accomplished only through the agency of cellular activity. This phagocytosis they believed could be accomplished by the bronchial epithelium, lymphoid wandering cells and by the alveolar epithelium. Traube thought that the acicular nature of the carbon particles would account for their tendency to pierce the delicate alveolar walls and then to migrate to other parts by the lymphatic channels. Rindfleisch accepted this latter view, laid stress upon the gritty hardness of the particles and believed that through the impact of the air current the particles may be driven through the superficial tissues. He furthermore pointed out that when these foreign particles had entered the lymph spaces they not uncommonly became incorporated within cells having phagocytic properties.

The theory of the phagocytic transport of the foreign particles continued to gain ground but there was no agreement concerning the nature of the active cell. Slavjanksy and Ins believed that the leucocytes were most active, while Ruppert, Schottelius, and others believed that the alveolar epithelium picked up the carbon from the air sacs. Arnold was divided in his views, considering that both types of cells were capable of carrying out this function, while, furthermore, he believed that under certain conditions migration of pigment might occur in the absence of phagocytic

cells. Even to the present time, observers are not in unison concerning the taking up and storage of the pigment which reaches the lung. The exact nature of the phagocytic cells, and these seem to be the active participants in the accumulation of carbon pigment in the pulmonary structures, is still in debate. In a recent study, however, it appears to us that Haythorn has conclusively shown that although pigment may appear in a variety of cells, the important cell acting as a carrier from the air sac to the interstitial tissue and the lymphatics of the lung, is an endothelial cell.

Although, in the early days of cellular pathology (1858) the finding of extensive pulmonary anthracosis was unusual, the situation has changed much in the present day. Then as now, the most intense examples of pigmentation of the lung were found among the coal miners, and it was particularly to these that Pearson, just a century ago referred, when he first applied the name anthracosis to the pulmonary condition. Apparently, early in the last century, in the course of ordinary life the accumulation of pigmented dust bodies within the lung was hardly sufficient to attract the attention. At that time, the use of coal was less general among the housekeepers and the combustion of wood was relatively complete, with but slight pollution of the air. Then, too, coal was not in as general use in industries nor had the use of the steam engine found a definite place in manufacture.

Today, the use of coal forms the main source of energy for the remarkable industries which began in the middle of the nineteenth century. We need not indicate by figures or statistics the extent to which our progress is determined by the use of coal. Nor is it within our province to indicate, the enormous losses entailed in the incomplete combustion of coal. The main fact stands before us today that in every city where householders use coal or in which manufactures of any capacity are located, the air shows a greater or less pollution by carbon particles. Today, it is almost possible to gauge the extent of the manufactures within a city by estimating the quantity of carbon in the atmosphere. In other words, what, not so many years ago was a rather unusual aërial condition, today forms a constant finding and has added a nuisance which affects the well-being of the community. No longer may we regard the presence of carbon in the air of large cities as a harmless factor. And furthermore, the gradual accumulation of this foreign material within the respiratory tract has a definite effect upon the tissues in reducing their functional activity and in possibly leading to secondary disturbances affecting our general bodily health.

The following observations have been made upon a series of autopsies, in which the deposit of carbon pigment within the lungs was particularly noted. These observations were made upon civilians not engaged in coal-

mining. The majority of them had been residents of the Pittsburgh district for the greater part of their lives. We were unable to account for the great variation, which occurred in the intensity of the pigmentation among the different individuals, particularly when their respective occupations appear to have had no relation to the amount of the pigment deposit in the lungs. Thus one of the most markedly pigmented lungs was obtained from a peddler, in whose history we could find no particular association with a sooty atmosphere or industry. It is possible that the tissues of different individuals store the foreign particles from the air with different degrees of activity.

Admitting that but few individuals today can escape the accumulation of carbon particles in the respiratory system, it may be suggested that the condition should be looked upon as a normal process. This attitude has been the dominant one in the discussion of pulmonary anthracosis. As, however, we must today freely admit that individuals living under different circumstances and in different communities suffer unequally from the quantity of inhaled dust, it is impossible for us to designate all of these as normal conditions. That a small amount of anthracosis of the lungs is not incompatible with good health is obvious to all who have observed the condition in many autopsies. That, however, certain communities are subject to greater pollution of the air by smoke than others, and that the individuals in these communities suffer in an equally greater degree from the inhalation of soot and smoke is also obvious to those who have had an opportunity of comparing the lungs from different localities. The pathologist has no difficulty in recognizing lung specimens from large manufacturing cities.

Thus we are able to observe variations from the almost non-pigmented lung tissue obtained from those living far distant from cities, to the more intensely pigmented lungs, the coal miner's lung illustrating the extreme degree of carbon deposit. There is, however, some difference between the deeply pigmented coal miner's lung and that obtained from the city dweller. The carbon dust as inhaled in the coal mines is considerably coarser than the fine particles of soot found in the city air. Moreover, the dust in coal mines is made up of fine angular and rough particles, while soot is a mixture of a very fine amorphous carbon and ash.

Anatomical Considerations.

The deposition of carbon pigment in the lungs from the dust-laden air is dependent upon the respiratory function and the activity of the lymphatics. The inhaled air with its carbon particles is carried to varying depths into the lung tissue. The major amount of the foreign material adheres to the moist walls of the respiratory passages and never reaches the lung tissue proper. It is possible, and microscopical analysis seems to

confirm this, that the foreign material that adheres to the mucus membranes of the nose, pharynx, trachea, and larger bronchi is but rarely carried into the tissues of these tracts, but lying in the secreted mucus, is carried upwards and is eventually expelled. The relatively lesser quantity of dust and carbon which reaches the lung alveoli also becomes adherent to the moist surfaces of the alveolar sacs and then by the activity of certain cells which have been studied and described by Haythorn, these particles are eventually carried into the lymphatics of the alveolar wall where they are disposed of by the lymphatic system of the part. The subsequent distribution is to a great extent determined by the site of absorption within the lung. Thus the carbon particles which have found their way into the air sacs near the surface of the lung, gradually accumulate within the lymphatics of the visceral pleura, while the carbon which is collected from the more centrally placed alveoli, accumulates about the lymphatic channels which drain that particular area. The tendency of this absorbed carbon is to pass from the finer lymphatic channels of the alveolar walls to the larger passages, eventually reaching a lymph node where the onward progress of the particles is impeded by the filtering action of this structure. In the main, the lymphatic drainage of the entire lung converges at the hilus and passes into the peri-bronchial glands located in this part.

The lymphatics of the visceral pleura form an intricate network, of channels which surround each lobule. The lymphatics upon the pleural surface of these lobules can, at times, be recognized by the naked eye. Many anastomoses occur and the larger channels drain towards the hilus. Communications between the surface lymphatics and those within the organ have also been demonstrated.

A somewhat similar system of lymphatic channels have been demonstrated about those lobules which lie within the lung. Not only is there a system of lymphatic channels about the lobules but small passages extend into the individual alveolar walls. Sikorsky, as well as Wittich claimed to have demonstrated small patent communications between the lymphatic channels in the alveolar walls and the air sacs. By this means, it was suggested, that foreign materials within the air sacs could find a ready passage into the interstitial lymphatic system. In 1878 Rindfleisch suggested similar passages for the entrance of coal pigment into the lung tissues. He believed that the fine dust particles could pass directly from theair sac into the interstitial lymphatic channels without the intervention of phagocytic cells. He did appreciate the rôle of phagocytosis in the subsequent transpotation and storage of the foreign material. It would appear, however, with the more recent studies that the migration of the dust particles from the air sacs occurs only through the agency of certain wandering cells.

To thoroughly appreciate the progressive pigmentation of the lung

substance by the inhalation of carbon particles, the general mechanism of respiration, as well as the efficient lymphatic drainage of all the air sacs must be understood. The important conclusions of Beitzke and Most, that the lymphatics of the lung and visceral pleura have no direct communication with those of the head, neck, or abdomen, and the fact that carbon particles are rarely found in the circulating blood indicate that pulmonary anthracosis is developed through the activity of the respiratory functions alone. It is, therefore, quite out of place, here, to discuss the claims of Calmette, and his associates, for the origin of pulmonary anthracosis in the alimentary tract. A more extensive review and study of the relation of intestinal absorption to anthracosis is given by Montgomery. This author from his own experiments concluded that the respiratory route alone was the important one leading to pulmonary anthracosis.

Distribution of Pigment Beneath the Visceral Pleura.

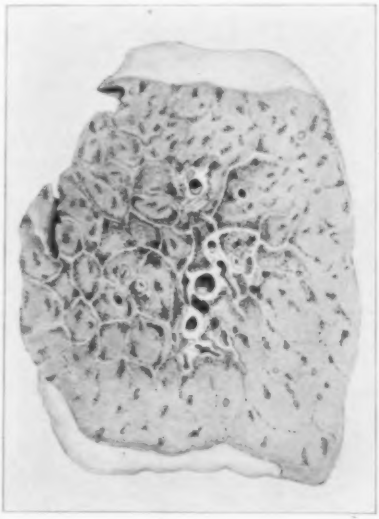
At first sight, when the lung is examined externally, the distribution of the deposit of carbon pigment seems to be irregular and without any association with the anatomical structure of the lung. The pigment is deposited in small granular masses, which, in their beginning, occupy areas less than of pin-head size. Sometimes it would appear that the deposit is in the nature of lines which, however, on slight magnification are found to be the coalesence of numerous small granular points.

As the deposit becomes more extensive, the pigment is found to follow a definite arrangement, and the anatomical structures which, in the non-pigmented lung are not visible, are mapped out by the deposit. Thus the sub-pleural pigmentation is found to pick out the septa dividing the lobules of the lung. This geographical marking is more particularly evident in the early stages of the pigmentation prior to the diffuse deposition of the pigment with the consequent obliteration of the early linear markings. Whereas in the early stages of the deposit, the septa of the lobules show fine linear deposits of pigment, the increasing accumulation of the carbon leads to an irregular thickness of these lines and the conversion of them into small chains of nodules or to the development of flat or shot-like masses in the sub-pleural tissues. Gradually the deposit extends from the septa into the tissues of the lobules until blotches of pigment become prominent. All gradations, from the finest hair-like lines in the septa, to diffuse pigmented areas in which the normal color of lung substance cannot be recognized, are not uncommonly seen in the same lung.

The macroscopic appearance of the sub-pleural tissues is a very good gauge as to the actual amount of carbon pigment contained in the lung. That is, with the deposit of such an obvious pigment no difficulty is experienced in distinguishing its presence or in gauging the amount present in each portion of the tissue examined. It is well, however, to recognize that the

amount of carbon pigment on the surface does not necessarily indicate the extent or distribution of the pigment in any part of the lung tissue. There are factors arising with each lung and within each lobe which tend to modify the amount of pigment within the tissue.

Although the pigment follows the septa of the lung lobules, the distribution upon the surface is by no means uniform. It has been repeatedly observed that the amount of pigment in the different lobes as well as in the different portions of the same lobe varies very considerably. The distribution of the pigment in the sub-pleural tissues is dependent upon the course of the lymphatic stream. But, as has been indicated by S. R.



Early Anthracotic Deposit along Interlobular Septa.

Haythorn, the presence of carbon pigment within the lung may have a marked effect upon the subsequent condition of these lymphatics. Thus, as we shall discuss later, the deposition of carbon pigment resulting through the activity of certain phagocytic cells has a tendency to stimulate tissue changes which modify the architecture of the organ. It is most probable that by this means the deposit occurring in the lung tissue does not always appear in the same characters but, according to the particular tissue reaction (fibrosis), a modification of the lymphatic system leads to an altered physiological process in which the amount of deposit may be increased or decreased.

In the examination of a series of lungs it soon becomes evident that there are certain areas in the normal organ, which become involved earlier than others, and which usually show the most intense pigmentation in the later

stages of the process. Thus in young adults who show no evidence of other diseased processes in the lung, the pigment is more prominent in the apex of the upper lobe, the anterior border of the upper lobe, and the posterior border of the upper and lower lobes. Even in these three areas the distribution of the pigment is by no means uniform, for in different individuals the grades of intensity of the deposit differ somewhat within these locations.

It is the usual observation that the least pigmented portions of the pleural surface of the lung are the diaphragmatic and the interlobar surfaces. It is not uncommon, however, to observe a sharp line of pigmentation separating the out surfaces of the pleura from the interlobar areas. At the border of each lobe, as it lies in apposition to its fellow, there is a marked pigmented zone, more intense than the deposit upon the free surface, and serving as a boundary between the pigmented pleura and the non-pigmented interlobar surfaces.

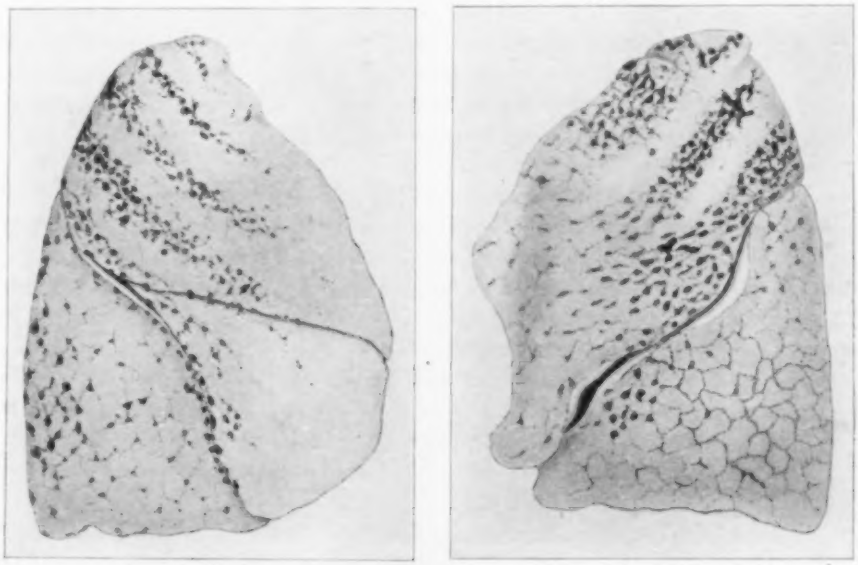
The distribution of pigment in the apex of the lung varies according to the shape of the part and to the character of the dome of the chest cavity. As has been pointed out by Schmorl it is not uncommon to have an unusual prominence of the upper ribs and irregular folds of the parietal pleura forming bands which divide the otherwise round dome of the chest cavity into several smaller compartments. These abnormal ridges are very common, but are not constant in their disposition. Not uncommonly they pass from behind inwards and forwards crossing the dome in an arched and rather spiral direction, the anterior extremity passing towards the hilus of the lung. At other times, folds of parietal pleura pass from behind upwards and forwards, crossing the highest points of the pleural sac. When these folds are marked, a definite depression is left upon the lung surface, particularly if the lung is unduly distended by emphysema or pneumonia. This depression is observed in the nature of a groove looking not unlike the vertical grooves seen over the right lobe of the liver (Liebermeister's groove). These grooves become more marked and more permanent with the age of the individual. Not only do they present depressions in the soft and spongy tissues of the organ, which, in the early years of life, can easily be obliterated, but in the course of years they remain as definite areas of retraction where the lung substance does not expand nor develop equally with the rest of the tissue. Thus in the apical grooves the lung tissue is inhibited in its growth and its functional activity is hindered by obstructing bands. Moreover, the lung tissue opposite the depths of the grooves is prone to become fibrosed or to develop adhesions to the parietal pleura.

These apical grooves are also to be recognized in the variation of the deposit of the pigment. The grooves when well marked attract the attention by showing a lessened amount of pigment than the surrounding tissue. When several well marked grooves occupy the apex of the lung,

then this part of the lobe appears to contain decidedly less pigment than other parts. Yet on closer examination, although the apical pleura may appear to contain less pigment than the other pleural areas, this is due to the absence of pigment in the grooves themselves, and not to the variation of pigment in the parenchyma of the lobe.

The ridges bounding these grooves usually show an unusual pigmentation. The extent, however, of the deposit on the borders of the grooves is not uniform in that it is not uncommon to observe one border deeply pigmented while its fellow on the opposite side contains but little carbon.

The intensity of the pigmentation along the posterior border of the upper



Non-Pigmented Rib Grooves of Lung.

and lower lobes is commonly the most marked in the entire organ. From the early beginning of a tortoise shell marking indicating the division of the lobules, the condition progresses until the pigmentation produces one diffuse coloration of the pleural tissues.

Furthermore, there are two important considerations respecting the localization of anthracotic pigment in the pleura. The first of these is the relation of the pigment deposit to the position of the intercostal spaces and the ribs. The second is the relation of the pigment deposit to the opposed pleural surfaces between the neighboring lobes.

In respect to the relation of the pigment to the ribs and intercostal spaces there have been a number of views expressed. As above stated,

our attention has been particularly attracted to this question through the observations of Schmorl upon the apical grooves of the lung. Similar rib impressions are found in adults upon the surfaces of both the upper and lower lobes. Schmorl in 1901 indicated that the uppermost ribs produced individual impressions upon the lung substance which were easily recognized at autopsy. Schmorl found these depressions in children, but noted that they tended to disappear with advancing age. He believed that the depressions were the result of the undeveloped chest pressing upon the lung substance and that with the development of the thorax, in the normal individual, the pressure upon the lung was much relieved. He noted, however, that in these individuals, whom we are prone to look upon as possessing the anatomical character of a tuberculous subject, the flat chest, these grooves or rib depressions upon the lung remained permanently. Thus he believed that the anatomical characteristics of the chest altered the relationship of the lung to the pleural cavity which in the undeveloped condition was prone to bring about those anatomical changes of the lung, inviting tuberculosis.

The grooves in the lung tissue had the effect of compressing both the lymphatic and blood vessels. Likewise a certain interference might be produced in compression of the bronchial tree. These pathological conditions tended towards a stasis of the circulation of the part, permitting a more ready development of the tuberculous process.

It has, furthermore, been shown that not only do the ribs in the uppermost portion of the thorax leave their impression on the lung tissue, but that such marks may be distinguished for the entire series of ribs down to the 8th or 9th. These rib markings or impressions are more readily followed by observing the deposit of pigment by the actual depressions produced upon the lung substance.

As one will readily appreciate, the intensity of the impressions of the ribs upon the lung varies in different individuals. Not uncommonly, the thorax is of such dimensions or its capacity bears such a relation to the lung, that little or no effect of rib pressure is to be noted. Under those conditions in which the volume and consistence of the lung is increased, as in lobar pneumonia, the rib depressions are temporarily more decidedly marked.

Peiser has studied a series of cases and finds that the rib grooves are not well marked in the infant. In this he differs from Schmorl. He believes that the rib grooves increase in their depth as the individual assumes the upright position and the thoracic wall sinks. As the thorax, with increasing age, gradually assumes its new level, the upper ribs become more prominent on the inner wall of the thorax. These then produce depressions upon the lung surface. Not only does the sinking of the thoracic wall lead to the prominence of the rib margins, but the respiratory movements

are altered, there being a diminished respiratory activity established. This in its turn has the effect of producing a pulmonary stasis and a lessened elasticity of the lung. Peiser believes that with the altered condition of the respiration, the character of the lung substance changes so that the rib grooves are more readily produced.

Further observations have recently been made by Orsos. He studied the mechanics of respiration as regards the relationship of the expanding thoracic wall to the spongy lung substance within. He indicates that the thorax, constituting a closed cavity, has its walls made up of parts which are of different composition. In part, the wall consists of solid structures, the ribs, while in other places soft portions make up a part of the active walls. He points out that the effect of these two types of tissue upon the lung substance is different. The solid ribs, he believes, are more active in producing a suction by the expanding chest and a compression by the contracting chest wall. This greater activity in relation to a part of the chest wall has its effect upon the lung substance in that the tissue immediately opposite the firm ribs is functionally more active during the respiratory movements. The inactivity of the intercostal spaces is not only to be observed in the smaller alveolar spaces, but also in the more sluggish lymphatic drainage leading to the greater deposition of the insoluble carbon particles. Thus in the adult, the intercostal spaces become more richly marked by the deposit of anthracotic materials.

In discussing the views expressed by Orsos, an opposite stand was taken by Marchand, Aschoff, and Beitzke, in that each of them expressed his belief that the greater deposit of pigment occurred in the areas mapped out by the ribs.

In our own observations, we must, in the main, agree with the finding of Orsos. Some difficulty is experienced in determining which portion of the lung lay opposite the ribs, particularly when there have been no marked depressions, while the deposit of pigment is quite decided. There can, however, be no doubt as to the depressions opposite the first, second, or third rib, and in these situations, the grooves which are very decided contain less pigment than the high points of the ridges. At this point, however, it is necessary to introduce a word of explanation in discussion of the pigment deposit in and about the costal grooves. It is best to study those lungs which are moderately advanced in the anthracotic process, and which are not altered by the presence of adhesions. Inflammation introduces a factor which modifies the normal distribution of pigment so that we can no longer ascribe our findings to the influence of the costal grooves alone. We shall discuss the effect of inflammation upon the deposit of coal pigment at another place.

It is, furthermore, to be indicated, that the deposit of pigment along the intercostal areas is not uniform. Although the margins of the grooves as

well as the intercostal spaces contain the greater amount of the pigment while the depth of the groove is almost always free, it is impossible to make a common statement as to the exact outline of the deposit for each groove. No doubt, the intensity of the pigmentation is determined to a certain extent, by the individual characters, such as the prominence of the ribs, the corresponding depth of the groove, and the local pressure upon the lymph and blood vessels.

In support of the views of Orsos that the cavity of the grooves exhibit less pigmentation than the surrounding portions, is the fact that the natural depression as well as the opposed pleural surfaces between the lobes have the same characters as the rib grooves in being less pigmented than other parts. It is the common observation to find a pale non-pigmented pleura on the interlobar surfaces while the external visceral pleura is mottled by a pigment deposit. The same is true of the diaphragmatic surface. Here, too, a less amount of pigment accumulates. This variation in the distribution of the pigment upon the pleural surfaces is not dependent upon the difference of the respiratory function of the lung alveoli beneath these parts, nor is it due to a difference in the character of the distribution of the lymphatic channels which surround the lung alveoli, but it is dependent upon outer influences of pressure which modify the capacity both of the alveoli and lymphatics. In the normal lung these influences of pressure are to be observed mainly in the rib grooves, the interlobar and diaphragmatic surfaces. It is possible that the presence of points of pressure upon the lung tissue has the quality of massaging the parts during respiratory activity and thus driving the particles of pigment more rapidly to other parts. We are inclined to believe that this quality of massaging the parts by intermittent friction plays the important rôle of preventing the accumulation of carbon pigment in the given regions of the lung. As we shall point out later, the lack of flow in the lymphatic system does not prevent the accumulation of foreign particles. Stasis of the lymphatic system, although preventing the fluid within the channels from flowing with normal rapidity has little effect upon the migration of the cellular elements, which are the main means by which the foreign material is transported. Thus, although stasis prevents the proper flow of the serum through the lymph channels, it permits the wandering of phagocytes into the obstructed region where these may accumulate in undue proportion. These wandering cells with their pigment burden are the chief causes for the pigmentation of the given areas of lung tissue.

Interstitial Pulmonary Anthracosis.

The nature of the distribution of carbon pigment in relation to the pulmonary alveoli within the lung is very similar to that observed upon the pleural surface. We do not, however, have an opportunity of viewing

the pigment in the same manner. Thus, in a cross section of the lung we do not have the opportunity of observing the surface of the lobules, but see only cross sections of the partitions. Thus for the most part our attention is attracted to the deposition of pigment at the points where the partitions meet. In these situations we observe small nodular deposits not uncommonly the size of pin-heads. At first sight, it would appear that the amount of pigment within the lung is relatively less than that observed on the surface. Nevertheless, it can be observed that the total amount of pigment within the lung tissue bears a relation to the quantity observed on the surface. In the normal lung, however, the distribution within the tissue is more uniform than the distribution of carbon in the pleura and there is not the macroscopic variation in different parts of the lobes, save at the hilus where the parenchyma is more pigmented on account of the greater accumulation in small lymphatic channels and nodes.

Furthermore, the unequal distribution of the pigment as it is observed upon the pleural surface has no direct relation to the deposition within the organ. The lack of pigment upon the interlobar surfaces and in the rib grooves is only a superficial condition and does not affect the deeper underlying lobules. The earliest deposits of coal pigment are to be looked for mainly in the perivascular lymphatics of the smaller branches of the pulmonary artery, subsequently, pigment appears in the regions of the small bronchi and venules. In all of these situations, its presence becomes more marked with the increasing quantities of soot that are constantly inhaled.

As the accumulations of pigment gradually increase, they not only form lines along the septa of the lobules and the vascular channels, but nodular collections appear at the points of junction of the various lymph channels, where small receptacula are formed. These nodules become so prominent that they are readily felt by the finger, and at times the course of the lymph channel can be detected by the feel.

Tissue changes may or may not accompany these larger depositions of pigment. In the majority of instances, however, a process of fibrosis, not accompanied by any inflammatory exudate, makes its appearance and surrounds each pigmentary nodule. These can be detected by the naked eye, while the larger ones which are short-like and gritty, are commonly spoken of as "anthracotic nodules."

In none of our specimens were we able to observe any uniform variation in the deposit of the anthracotic pigment within the lung of normal individuals. The greater quantity of pigment along the various channels has been indicated above but no unequal distribution of pigment has been observed which would in any way correspond to the unequal distribution beneath the pleura. True it is, however, that certain pathological processes

in the lung tissue may modify the distribution of the pigment to a very great degree. We have, however, failed to find any evidence of excessive deposit in the deep tissues at the apex of the upper lobe. In fact, in our experience, more pigment was found toward the hilus than at the periphery, regardless of the pleural distribution. Furthermore, the more marked areas of pigment deposit in the pleura are confined to this superficial layer and do not involve the underlying parts.

In several specimens of lungs from elderly individuals, who showed a moderate amount of emphysema in portions of the lobes near the surface, it was observed that an unequal distribution of the anthracotic pigment was present. Those lobules showing emphysema contained less pigment than elsewhere. This condition was not only apparent by the greater area occupied by the emphysematous tissues but was real, in indicating less carbon in the affected tissues. When such emphysematous areas occupy the surface alveoli, and when these lie upon the ridges of the costal markings, it is then found that the borders of the grooves contain less pigment than the surrounding areas. Thus the contention of Marchand and others that the ridges between the intercostal grooves accumulate less pigment may have its explanation in the presence of these emphysematous alveoli.

The Modification of Anthracotic Deposits by Other Factors.

It is evident, from what we have said, that every individual has a greater or less quantity of carbon accumulate in the lungs, and that this accumulation varies in the normal lung according to the amount of carbon in the inspired air. With advancing age, the quantity of pigment continues to increase until a relative standard for the community in which he resides is reached. This pigment in the normal lung becomes deposited, through the agency of phagocytic cells within the lymphatics and its particular location beneath the pleura of the lung, is dependent upon the distribution of the lymph channels and the relationship of the opposed pleural surfaces which varies to some extent in all individuals. The distribution within the normal lung substance, appears to be entirely determined by the circulation within the lymphatics.

Whereas, under normal conditions we may look for certain common features in the anthracotic deposits in the lungs, there are also pathological processes which bring about a modification of the deposit. Thus we find that certain disturbances within the lung tissue have an effect of inducing greater deposits of pigment within localized areas. And it is probable that this new condition of excessive pigment deposit brings about further changes instituting a vicious circle.

Local Pleural Inflammation.—It is not an infrequent observation to find a greater quantity of pigment in the immediate vicinity of a band of

pleural adhesions. By some it has been suggested that these adhesions are the result of the unusual deposit which leads to an excessive irritation in the surrounding tissues. When, however, we study the development of pleural adhesions we find that the fibrous bands in children show little or no difference in the deposit of pigment from other parts of the lung. With advancing age, however, the accumulation of carbon at the point of attachment of the adhesion to the lung becomes greater. A difference is noted too, in the character of the adhesions, for those which have only a superficial attachment and do not induce a fibrosis of the neighboring lung tissue, show less deposit. It is obvious that we must differentiate those pigmentary processes associated with primary pleural adhesions from those that we associated with primary lung disturbances (tuberculosis), in which adhesions may also be present. Of this latter type we shall speak again.

The best example of pleural adhesions for study, are those developing between two surfaces which are in constant frictional contact, as well as the bands of adhesions which sometimes follow fibrinous pleurisy in early life. Of the former type, we meet with adhesions at the apex arising from a rib groove which, under ordinary cirumstances, is non-pigmented. Here a firm band of adhesion binds a portion of the lung to the chest wall. The fibrous band not alone attaches itself to the surface of the visceral pleura but bands of tissue enter to a greater or lesser extent the fibrous layer of the lung covering and the interstitial septa, and alveolar walls. The fibrosis spreads diffusely through the tissue surrounding the blood vessels and encroaches upon the loose tissue of the lymphatics. Some of the lymph channels become completely obliterated, others are altered in their course.

It is probable that some of these bands of adhesions develop without the presence of an acute process and like the presence of milk spots of the heart, induce a progressive fibrosis which alters the relationship of the surrounding tissues. The pleura with its vascular tissues is altered to a sclerosed structure in which the lymph channels are reduced to mere clefts. In this condition not only is there a stasis of the fluid within these channels but there is also a filtering out of the phagocytic cells which are constantly wandering from the alveoli towards the larger lymphatic system at the hilus. Gradually the accumulation of cells is sufficient to show the increased quantity of pigment within the part. It would appear, according to Haythorn, that these migrating cells may live for a considerable period with the pigment within their protoplasm. Other phagocytes probably liberate their contents which become deposited in the interstices of the fibrosed areas. It is probable that the liberated carbon remains in the clefts between the cells and does not enter fixed tissue cells.

If the opportunity for the absorption of carbon pigment from the alveoli

be great, then the accumulation of this foreign material in the vicinity of adhesions becomes very marked. Nodules are formed which are hard and encroach upon the lung tissue. The lung alveoli are surrounded by a progressive fibrosis containing much carbon. It is more than probable, that when such excessive quantities of pigment are deposited that these again act as irritants, inducing greater adhesions. We do not believe that the inhalation of carbon in the normal lung will induce pleural adhesions unless some other factor within or upon the lung acts as a primary exciting cause. We have, upon repeated occasions, observed the lungs of mill workers and coal miners in whom the lung tissue had become intensely black through carbon deposit without there being any evidence of pleural adhesions.

We have never observed that acute pleurisy altered the deposit of pigment in the pleura. It has been observed that in acute inflammatory processes where the lymphatic channels of the pleura are filled with migrating and phagocytic cells that a considerable amount of pigment may be removed from the pleura to other parts. The exact bearing which this inflammatory migration might have upon the total pigment content could not be determined. The changes, however, were insufficient to produce any difference in the amount of pigment to be noted by the naked eye.

On the other hand, the chronic processes of the pleura not uncommonly had an effect similar to that observed associated with individual tags of adhesions. In cases where there were universal fibrous adhesions, the effect was not observed in the quantity of pigment deposit except where denser bands had developed. The diffuse and veil-like adhesions were without change in the vicinity of their attachment to the lung. A study of these indicated that the fibrous tissue of these adhesions had only a superficial attachment and did not involve the deep layer of the pleura. Where, however, the intensity of the chronic adhesive pleurisy was not uniform and where irregular bands were attached to the lung substance at various points, a more marked pigment deposit was prone to form.

In all instances where the more intense deposit of carbon pigment was associated with bands of adhesions, the process remained fairly superficial and localized. There was no invasion of the deeper parts by the continuous accumulation of pigment.

Inflammation of the Lung Substance.—Much has been indicated to associate pneumokoniosis with acute and chronic respiratory diseases. As early as 1717, Ramazzini drew attention to certain air-borne occupational diseases, and since then the greatest attention has been paid to diseases associated with inhalation of dust. Naturally, much interest has centered about the effect of inhaled dust of various kinds upon the lung and more particularly the relation, if any, that existed between these changes brought about by the deposits and inflammatory processes induced by bacteria.

The manner in which this relationship was established has not been entirely clear. By many (Ascher and others), however, tuberculosis has been looked upon as a process secondary to the deposition of the dust.

On the other hand, the relative infrequency of pulmonary tuberculosis amongst those who are engaged in work associated with much coal dust, has been pointed out by a number of authors (Ogle, Sommerfeld, Hirt). In the statistics, tuberculosis appears rather rare among coal miners. It would, therefore, appear that the inhalation of coal dust does not predispose to tuberculosis. The explanation for this appears to depend upon the morphological characters of the dust particles. On the other hand, Kuborn, Villaret, Versois, and others believe that the continued contact with coal dust leads to a true immunity against tuberculosis. Racine believed that coal contains substances which are antiseptic and disinfectant, and that this quality inhibits the growth of the tubercle bacilli, and Holman has shown similar disinfectant qualities in soot. Another (Idel) believed that the porous coal dust absorbed the tubercle bacilli and rendered them inert, while Wainwright and Nichols thought the partially soluble calcium salts contained within the coal gave the animal body protection against these organisms. The indication that the presence of coal dust within lungs had a favorable effect upon respiratory diseases, led Guillot to use the inhalation of coal dust for therapeutic purposes. As early as 1793 Beddoes established a sanitarium near Bristol where he treated chronic diseases, as asthma and consumption, by the inhalation of charcoal. The patients were placed in a dusting box where by mechanical means the charcoal was distributed into the air. However, it was later shown by Papasotiriu that coal dust had no influence upon the growth of the tubercle bacilli upon glycerine agar cultures, while Cornet was unable to protect animals against air borne tuberculosis by means of the inhalation of carbon dust. It has been indicated by Bartel and Neuman that anthracosis increases the virulence of tuberculosis in experimental animal infection.

It is more than probable that the infrequent presence of tuberculosis amongst those developing extensive anthracosis has its explanation in certain anatomical changes in the respiratory system, and it is possible, as is indicated by Fraenkel and admitted by Racine, Wainwright and Nichols, that the infrequence of progressive tuberculosis among the coal miners is due to tissue obstruction of the lymphatic channels brought about by the anthracosis.

Ascher's observations that the extensive inhalation of smoke as well as soft coal increases the mortality in tuberculosis, is not in agreement with other general findings. It has, however, been shown by Hart that there is a difference in the composition of smoke particles and coal dust, and that the former contains some of the products of coal distillation. Again it has been shown by others that laborers engaged in atmospheres containing

much coal dust, such as stokers, coal heavers, and chimney sweeps, are just as immune as coal miners to tuberculosis (Markel, Versois). Lewin found that 92.3 per cent. of chimney sweeps who had followed this occupation for more than ten years were free from respiratory diseases.

Our own observations have concerned themselves in determining the influence of the pigment upon the lung tissue as well as its relation to the tissue changes in acute and chronic processes within the lung. We can offer no statistics which show the relation which the pigment deposit has to the occurrence of infections of the lung. This study also deals with the effect of certain respiratory diseases upon the subsequent deposition of carbon pigment.

As it has been shown that the anthracotic material owes its presence to the activity of certain phagocytic cells, it is evident that an interesting problem confronts us in determining what rôle similar cells stirred to activity by a bacterial irritant will have upon the foreign materials, as carbon pigment, which are already present in the interstitial tissues.

In the study of lung tissues showing acute pneumonia, one is confronted with the picture of a lesser pigmentation in the areas involved in the pneumonia. The appearance is quite decided, and a fairly sharp line of demarcation separates the pneumonic area from the more healthy tissues. Within the consolidated portion of the lung the carbon pigment is seen only in the more prominent nodular deposits, while the pigment observed along the interlobular septa in the normal lung can no longer be traced. The diffuse pigmentary deposit in the alveolar walls is also overshadowed by the color of the exudate, be this grey or red. However, when viewing the lung from its pleural surface, no change in the amount of pigment deposit is observed in the superficial portions.

Although a decided diminution of pigment within the consolidated area is apparent, the fact that pigment is actually removed from the tissue involved in the inflammatory process can not be demonstrated in the lung after its recovery from pneumonia. We have not been able to define the areas of consolidation after recovery from the disease, by the amount of pigment in the tissues.

It does seem, however, that some of the pigment in the lung tissue becomes dislodged during the active migration of cells. During the late stages of pneumonia, the lymphatic channels contain a greater number of pigment-bearing cells than are observed in the uninvolved lung. It may be that, due to the stagnation of the lymphatic system in anthracosis, these pigment bearing cells do not have an opportunity of migrating from the pulmonary structures but remain stagnant in the dilated lymph channels. The macroscopic appearances of a diminution of carbon pigment during the acute stages of the pneumonic process is more apparent than real, and

is due to the overshadowing of the normal lung structures by the cellular exudate of the inflammation.

On the other hand, we have repeatedly observed that in isolated areas of fibrosis of the lung where no evidence of tuberculosis was found that the amount of anthracotic pigment was much increased over that present elsewhere in the same lung. We can, however, hardly offer this as an indication that the sequel to an acute inflammatory process, ending in fibrosis is associated with an excessive pigmentary deposit. In a single case of well advanced organized pneumonia we observed some increase in the the amount of macroscopic pigmentation within the fibrosed area, as well as microscopic evidence of such increased deposit. Naturally, it is difficult to estimate the exact variations from the normal deposit in different parts of the same lung.

In no instance has the examination of pneumonic lungs shown that the presence of the anthracotic deposit has, in any way, modified the distribution of the acute process. It cannot be shown that the more intensely pigmented tissues are more readily subject to pneumonia than the other less involved areas. It has, however, been suggested by Haythorn that aside from the local pigmentation in the vicinity of the individual air sacs, the anthracotic process of the lung has a definite effect upon the lymphatic system and particularly the lymphatic channels. These channels which become narrowed and partly obstructed, are less efficient for carrying off the débris which accumulates in the acute inflammatory process. This stagnation impairs the process of resolution with the result that proper repair of the lung following pneumonia does not take place. Conditions of unresolved pneumonia and gangrene of lung are more common in lungs with marked anthracosis than in the less affected organs.

We have in many examples made observations upon the anatomical relationship between the anthracotic deposit and tuberculosis. It is immediately apparent that in the discussion of such a relationship we must clearly define the type of tuberculosis. Naturally, the effect of the distribution of the tuberculous process upon the anthracotic deposit will be different in acute miliary tuberculosis than in chronic localized tuberculous lesions, and similarly the reverse relationship, if such exists, will also differ with the various forms in which one meets the tuberculous process. Individually, both processes are dependent, for their local distribution, upon similar factors, the phagocytic activity of cells and the distribution of the lymphatics.

We have not been able to observe any direct bearing of the anthracotic process upon acute miliary tuberculosis, nor have we observed a greater tendency for the development of tuberculous lesions in the anthracotic areas than in other parts of the lung. In fact, lungs showing moderate anthracosis will have more acute miliary tubercles in the uninvolved por-

tions of the lung than in the anthracotic nodules. Nevertheless, we have observed that in the later stages of the process when the miliary tubercles had advanced to larger and more definite caseating areas that the localized areas of anthracosis not infrequently had gray tuberculous centers. It is probable, therefore, that the absence of tubercles within anthracotic nodules during the acute stage of the infection is, in part, due to the intense pigmentation obliterating the early tuberculous focus. As the anthracotic deposit is associated directly with the course of the lymphatic streams and particularly with those surrounding the blood vessels, it is to be expected from what we know of the distribution of tuberculosis that many tubercles

Anthracosis of Lung about a Tuberculous Focus.

will develop along these systems, in spite of the presence of anthracosis. As the individual miliary tuberculous foci increase in size they gradually obliterate the anthracotic areas with the change from an intensely pigmented tissue to one showing numerous gray nodules of various sizes. With the increase in number, the tissue gradually loses the intensity of its pigmented appearance.

A still more marked loss of anthracotic pigment from the lung is seen in caseous pneumonia. Here, instead of having many small gray nodules gradually obliterating the pigment within the lung, we observe a diffuse gray caseous tissue whose light color is in strong contrast to the pigment in other portions of the lung. Only a moderate amount of pigment deposit is seen in the caseous area, and this pigment lies in the areas of former

intense deposit. The grey color of the caseous areas not only represents the necrotic exudate within the alceoli but also indicates tissue changes, first proliferative, later degenerative, of the alveolar walls and their contents. It is during the process of proliferation in the alveolar walls and lung trabeculae that the former pigmented cells are stimulated to proliferation and probably migration which leads to a removal of the pigment in the particular area. What eventually becomes of the disturbed pigment in the lung tissue during the tuberculous process is difficult to say. In part, it finds its way towards the lymphatics at the hilus of the lung. In part, it may become removed by the destruction of the tissue and subsequent expectoration.

In the above processes, acute miliary tuberculosis and caseous pneumonia, it is evident that anthracotic process has no influence in localizing the infection. We have, however, observed that miliary tuberculosis is more prone to develop into a chronic caseous miliary form in lungs presenting much pigmentation than in those not affected.

Quite a different outcome is observed in localized chronic caseous tuberculous foci. The early stages of the tuberculous process simulates the lesions which we have just described. As the lesion enters the chronic stage one observes that instead of there being a diminution of pigment in the involved area, that gradually, and in direct proportion to the amount of fibrosis, the pigment deposit increases. Thus the periphery of the lesion, in which area the healing of the tuberculous mass is taking place, larger amounts of pigment are continuously laid down. We have never observed the macroscopic increase of pigment before the development of fibrosis in the lesion. Eventually the fibrosed mass becomes intensely black, and hard. These areas vary in size from a pea to a mass the size of a golf ball. When fully developed, the tissue with its pigment deposit resembles in consistency and color a hard rubber ball.

We have observed all stages of these pigmented masses surrounding tuberculous foci and it is evident that the pigment deposit develops upon the tuberculous lesion. The extent of the pigmented area is entirely dependent upon the reaction in the tissue of the tuberculous focus, and this reaction is always of the development of fibrosis. Where a tuberculous process by progressive caseation has led to cavity formation, there is no excessive pigmentation in the vicinity of the cavity until repair by fibrosis has begun in its walls.

Microscopically, it has been shown that the same cells which form the tubercle and which in themselves are phagocytic for tubercle bacilli, are also the cells most phagocytic for carbon pigment. Thus these cells constituting the tubercle are adapted for the localization of foreign dust particles, and being in excess of the number present in the normal parts of the lung may bring about an anthracotic deposit, with the tubercle. However, by

the time the pigment has accumulated in sufficiently large quantities to be recognized macroscopically, there has developed a secondary fibrosis inducing a vicious circle by obstructing new lymphatics and accumulating greater numbers of pigment laden cells.

Tissue Changes Induced by Carbon Pigment Within the Lung.—Today we have come to recognize that the term anthracosis does not refer alone to the presence of coal pigment within the lung, but also includes the tissue changes which accompany this deposit. As we have previously indicated we have come to recognize that the deposition of the carbon in the lung is brought about through the agency of phagocytic cells. It is not probable that inert carbon can enter the lung tissues by mechanical means alone. The contention of Klein, Sikorsky, Merkel and others that the physical characters of the foreign material is such that it may migrate between the cells in the alveolar walls without the assistance of wandering cells can no longer be supported. Hence it is evident that the very process of accumulating and carrying the pigment is a vital one, and has to do with the cells arising from the pulmonary tissues. It has been shown that the number of cells acting as phagocytes found within the alveoli is proportionate to the quantity of pigment in the air sac and thus, too, the activity of the wandering cells is dependent upon the inhaled carbon. As the engulfed pigment is prone to remain fixed for considerable periods of time, it even being claimed by some that the phagocyted pigment remains permanently within the wandering cells, there is a progressive accumulation of these cells in the lymph spaces of the alveolar walls. Their direction is mainly towards the larger lymphatic system at the hilus of the lung, but it is also probable that these cells may not only lie inactive for varying periods of time, within the interstitial lymph spaces, but are still capable of returning to the air sacs to encumber themselves with still more foreign material.

How long these cells of an endothelial type are able to remain dormant but still living, is very difficult to say, yet it has been demonstrated in tissues that pigmented cells having every appearance of fixed connective tissue when thoroughly analyzed and segregated from their surroundings were found to be endothelial cells.

It is the common observation to find a progressive accumulation of pigment bearing cells within the alveolar walls with advancing ages. As the cells increase in number within the lymph spaces the wall becomes thicker and the tissue has a more or less hyaline appearance between the aggregations of pigment granules. To a certain extent the increase in tissue is the result of a direct increase in the number of wandering cells. On the other hand, we have also been able to show that there is a definite increase in the connective tissues about the lymph channels with the laying down of heavy collagen strands.

With this fibrosis there is no increase in the elastic tissue; in fact, the areas of extensive change are poorer in elastic fibers than normal.

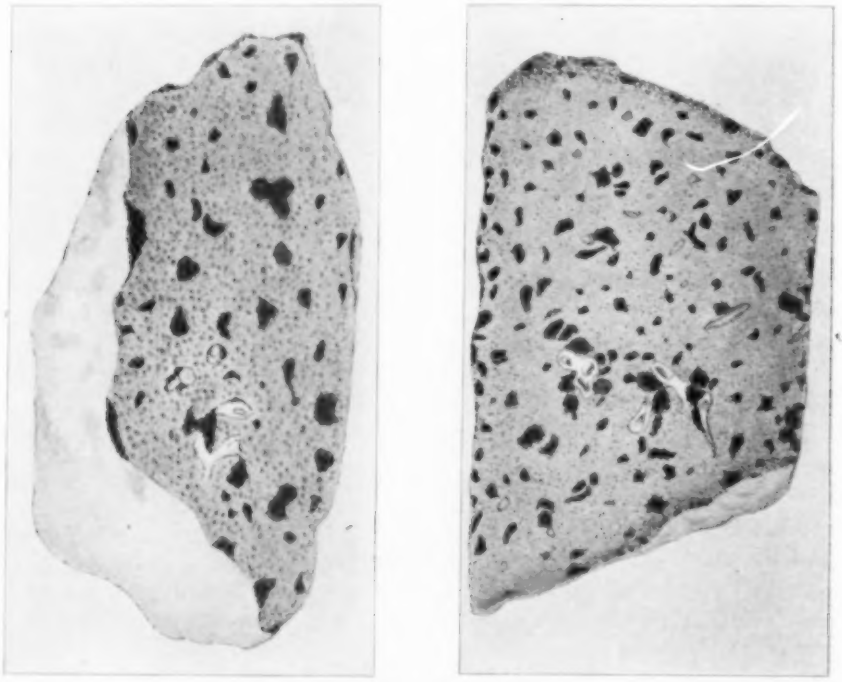
As we have previously indicated, the distribution of the inhaled dust in the lung is quite uniform, save for its distribution in the lymphatics of the pleura. Some (Arnold and also Boer) maintain that the deposition of soot is considerably greater in the upper lobe. This has not been our finding, though at times a difference has been observed between the two lungs. The accumulation of dust to that extent which induces secondary fibrosis will thus give rise to a fairly uniform tissue change in all lobes of the lung. This is a common finding inasfar as the lung tissue proper is concerned. It is probable that the fibrosis thus produced assists further with preventing a proper lymphatic circulation (Haythorn) and leads to the greater number of phagocytic cells becoming localized in the alveolar walls.

It is probable that the very nature of the phatocytic cells, being large and sluggish in activity, leads to their more ready localization in the lymph clefts than the more active leucocytes which deal with acute disturbances. If the normal functions of the endothelial phagocytic cells would be continuously carried out, it is improbable that as great a quantity of carbon would localize in the parenchymatous tissue of the lung, more of it finding its way to the large lymphatics and lymph glands at the hilus. The very condition which is brought about by the obstruction of the lymph clefts and small channels as well as the blocking of the lymph sinuses in the nodes about the bronchi tends to increase the localization of the large phagocytes close to the alveoli from which they obtain their pigment. Thus the nature of the pigment phagocytosis and the localization within the lymphatic spaces tends to bring about a vicious circle which, when a certain degree of anthracosis has developed, permits of a still more rapid deposit of pigment in the alveolar walls. It is about in this stage of the condition that the developing fibrosis leads to structural changes which impair the function of the lung tissue.

Other than inducing a diffuse fibrosis within the lung, there are also the nodular fibrotic masses surrounding accumulations of pigment bearing cells at the junction of the lymphatic channels. The more common of these are the size of wheat grains. The fibrosis assumes a concentric arrangement enclosing pigment which to a great extent lies free, but much of which is contained in the original phagocytic elements. Such nodules, however, may become much larger, forming isolated masses, three or four centimeters in diameter. It is probable, however, that these larger masses arising in the lung tissue have had other factors superadded, leading to their unusual development. The consistence of these is that of hard black rubber. Where calcareous masses are found in the center of such nodules, the previous existence of tuberculosis is strongly suggested. This asso-

ciation of anthracosis with chronic tuberculosis we have discussed above.

Anthracosis and Emphysema.—With extensive and diffuse development of pulmonary anthracosis in which tissue changes to a greater or less degree are developing, the activity of certain parts of the lung is impaired to such a degree that compensatory changes occur in other and more active parts. These compensatory changes are mainly evidenced in the development of emphysema. It would be difficult to indicate the se-



Nodular Dissemination of Anthracosis.

quence of events in laborers or coal miners. Here, from the very nature of their work emphysema would readily occur. We may, however, observe emphysema in indiyiduals with diffuse anthracosis whose work or whose thoracic condition would offer no explanation, for the compensatory expansion of certain lung areas. This we have on several occasions observed, and we were unable to find an explanation save in the diminished functional activity in those portions of the lung with marked anthracosis and fibrosis. The development of the emphysema observed in the positions is seen under other conditions.

The apex and the anterior border of the upper lobe are usually most involved. A rather remarkable feature associated with this emphysema is the disappearance of the anthracoti pigment from the emphysematous area. Where the alveoli become usually distended the pigment gradually disappears until the tissues look quite white (pulmonary albinism). This has been commented upon by Beitzke and others.

From our observations it would appear that this loss of pigment from the lung is the result of the greater local activity during the process of development of the emphysematous areas. The condition would simulate the lack of pigment observed in the interlobar pleura where the massage of these areas by constant friction seems to drive the pigment bearing cells into the larger lymphatics. This is probably also the case during the development of the emphysema where the lung alveoli are acted upon by the greater air pressure having the effect of repeated compression and relaxation. Thus the air contained within the alveoli has the effect of massaging the alveolar walls and likewise of driving onward the cells containing the pigment. A similar effect would also be had upon the free pigment within the lymphatic spaces of the alveolar wall. In these emphysematous areas the removal of the pigment is not associated with an inflammatory process assisted by active leucocytic phagocytes.

Quantitative Estimation of Carbon in Lung.

As we have indicated, a fair estimate for comparison can be made of the carbon deposit by the naked eye appearance. The pleural deposit of carbon, although not directly related to the presence of pigment in the inner portions of the lung, is nevertheless, a good guide to the quantity of foreign material in the organ. The pale grey or greyish-pink color of the lung of the rural inhabitant is readily distinguished from the mottled, streaked or slaty black tissues of the city dweller. Moreover, as we have indicated, the progressive increase of the carbon deposit, in the lung of every citizen in manufacturing communities, can be recognized and grouped into the age periods by decades, when the individual has lived fairly constantly in the same district. Individuals of similar occupation are expodes to relatively equal amounts of atmospheric carbon, and their respiratory tissues receive similar quantities of carbon by inhalation. On the other hand, in communities where within short ranges of distance the atmospheric conditions differ, and with this the carbon content of the air is very unequal, the people living or working but short distances apart are subjected to diverse conditions, the one inhaling much larger quantities of soot than the other.

There are so many factors associated with the deposit of soot in the lungs of human individuals that it is impossible to make any general statement

indicating the amounts for each. In truth, it is plain that those in smoky atmospheres have larger deposits, but we are often misled in our reference as to occupational influence. The millworker employed within the sheds in the manufacture of steel is often less exposed than his wife living within a quarter-mile range enveloped by the smoke clouds from the multitudinous stacks. The lungs of a peddler selling his wares to the foreign population of our smoke-laden valleys were found to contain more carbon than those of the millhand (see table, page 914).

As we feel convinced, from our observations, that the intestinal route has little or no practical significance for the deposit of carbon in the lungs, it does not appear that the degree of cleanliness, particularly of the mouth, bears any relation to pulmonary anthracosis. Carbon particles once lodging upon the moist surfaces of the nose, mouth, pharynx, and trachea, never assist in increasing the carbon of the lung. It is probable, as was shown by Haythorn's experiments, that only those carbon particles lying within the alveolar sacs can reach a permanent interstitial abode and that little if any carbon is phagocyted and carried into the tissues from the bronchi or bronchioles. Furthermore, it would appear, both from experimental and other observations, that the carbon reaching the lung alveoli is only a very small portion of the carbon content of the air as inspired, and this portion has reached the lung because it escaped contact with the moist mucous surfaces of the respiratory tract. Under the most trying circumstances of a smoky atmosphere we are amply protected by the sticky surfaces of tortuous tubes.

Difficult as it seems for carbon to reach the lungs, it appears equally difficult to dislodge the pigment when once it has been incorporated by the tissues. In fact, we may well believe that save under very abnormal circumstances, carbon once within lung tissue remains for life, and hence each year we add that amount to our store as we may have been exposed to city smokes. To gain some accurate information of the quantitative deposit of carbon in the lungs an analysis was made of the tissues. Previous analyses have been made determining the quantity of iron, silicate, copper, and other metallic deposits in the lungs of laborers.

Saito, in a series of experiments, estimated the quantity of dust inhaled from the air. Using measured quantities of dust (white lead), he determined the quantity taken up by the animal when exposed to the dust-laden air. He observed that only 4 to 24 per cent. of dust entering the nose was deposited in the respiratory organs, while the remaining quantity found its way to the intestine.

More recently Boer has made a relative quantitative estimation of the soot content of small portions of lung tissue. By his method, using only three cubic centimeters of lung tissue errors of calculation may possibly be great. He points out the error which would be obtained in comparing

lung tissue of unequal density or consistence, as for example that of emphysema or œdema, and confined his examination to normal lung tissue. Here too much variation may be encountered, whether or not much pigmented pleura is included in the portion under examination. Care in selection of the tissue can not wholly rule out errors of seroius import in the results. Furthermore, as the amount of carbon in these small portions of tissue was too small to weigh, he has used a colorimetric method suggested by Liefmann. The amount of carbon isolated from the lung examples was suspended in a mixture of oil and ether, and compared with a set of standard suspensions, prepared by suspending weighed quantities of nephthalin soot in the same vehicle. Such a colorimetric method cannot be relied upon, owing to the difference in the nature of the carbon in the lungs and naphthalin soot. Fresh soot has physical and chemical properties widely different from the carbon isolated from the lung by treatment with antiformin and alcohol. Isolated carbon from lungs has lost its flakiness and is quite granular, devoid of its phenols and acids. Its bulk is much less than the original soot from which it was derived, and in suspensions taken weight for weight it does not compare with the apparent mass of soot. It is, furthermore, to be noted that in isolating the lung carbon, care must be taken to free the final product of its fat and foreign calcareous matter which tends to remain incorporated in the residue.

In our determinations we took an entire lung, dissected the glands, large bronchi and adventitious tissue at the hilus, and minced the entire organ in a meat machine. The pulp was then divided among four half-liter flasks and to each was added enough of a 75 per cent. solution of antiformin to well fill the flask. The flasks were placed in the incubator and repeatedly shaken for four to six days. Two hundred cubic centimeters of alcohol were then added to each flask and the mixture centrifugalized, the residue being collected and returned to clean flasks. These materials were again subject to fresh digestion with antiformin for a period of four days, recollected, washed and for a third time acted upon by antiformin. After again collecting the residue and washing it, it was treated with 10 per cent. hydrochloric acid, repeatedly agitated and allowed to remain in contact for forty-eight hours. The residue now collected by the centrifuge and washed was in turn treated with acid-alcohol and ether until the supernatent fluid showed no evidence of fat. The ether suspension was then allowed to evaporate to dryness, and the collected residue repeatedly washed with distilled water to rid it of any contained salts. The final product consisted of a pure black, fine powder, denser than the light, fluffy soot masses found in the air. Under the microscope, angular carbon particles were alone present.

Case.	Age.	Occupation.	Residence.	Side.	Quantity of Carbon.
218	22	Laborer	Pittsburgh	Right	3.2
73	28	Peddler	Pittsburgh	Left	5.3
154	37	Laborer	Pittsburgh (6 yrs.)	Right	1.7
163	37	Housekeeper	Pittsburgh	Right	2.1
158	39	Clerk	Pittsburgh	Left	1.2
164	44	Housekeeper	Pittsburgh	Right	2.6
A-Q-8	47	Storekeeper	Ann Arbor	Right	0.145
A-Q-12	68	Laborer	Ann Arbor	Right	0.405
239	69	Carpenter	Pittsburgh	Right	2.81

I am indebted to Prof. A. S. Warthin for the material from Ann Arbor.

In our examination it is shown that the lungs of adult individuals resident in the Pittsburgh district have materially more carbon deposit than the lungs of the two individuals resident in a lesser manufacturing community. Our number for comparison is very small, but is, nevertheless, suggestive of community characteristics. On account of the slow and rather tedious process in isolating the carbon in a pure form, only one lung was examined in each case, so that the total pulmonary content is about double that indicated in the table. Furthermore, it is to be noted that the isolation of the carbon did not include that present in the peribronchial glands, where dense deposits are commonly found.

As was previously indicated, the lungs showing marked anthracosis are decidedly heavier than normal organs, but it must not be inferred that the extra weight is due to the foreign dust in the lungs. From our analysis of the carbon pigment in the lung it is evident that no material increase in weight is obtained directly from this source. On the other hand, it is well shown that a relatively small quantity of carbon in the lung can induce massive fibroid changes which alter the architecture and increase the bulk.

Summary.

Pulmonary anthracosis (not in coal miners) is distinctly an urban disease, and is proportionate to the smoke content of the air.

The soot is inspired and lodges in the pulmonary alveoli, from which it is carried by phagocytes into the lung tissue to become lodged in some portion of the pulmonary lymphatic system.

Although small quantities of carbon deposit in the lung may remain without harm, yet the quantity accumulating in the dweller of the larger cities has an accompanying greater or less fibrosis impairing the elasticity as well as altering the functional capacity of the organ.

The distribution of carbon is fairly uniform in the parenchyma of the different lobes, but there is a considerable variation in the distribution of the pleural deposit. The interlobar and diaphragmatic pleural surfaces show the least pigment. Moreover, less pigment is found in the grooves produced by the ribs or abnormal bands.

Carbon tends to accumulate at the nodal points of junction of the lymphatic channels. The cellular migration of carbon may lead to unusual accumulations in certain areas particularly well demonstrated in the deposit about chronic tuberculous lesions.

Carbon deposits by inducing fibrosis tend to encapsulate chronic tuberculous foci.

Pulmonary anthracosis by itself does not appear to stimulate the production of pleural adhesions.

The actual amount of carbon present in the lungs of different individuals varies considerably and is dependent, in part at least, on the age, occupation, residence and condition of the lungs (emphysema, collapse, tuberculosis).

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POTASSIUM TELLURITE AS AN INDICATOR OF MICROBIAL LIFE.

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INTRODUCTION.

The fact that selenium and tellurium compounds, when brought into the living organism, are decomposed by the metabolic processes of the cells with the formation of substances of characteristic odor has been known for a long time. Gmelin (1) and Hansen (2) were the first to investigate this and toward the close of the nineteenth century the phenomenon had been closely studied and its nature determined upon by Hoffmeister (4) as a synthetical, methylating process. Gmelin, himself, in the course of his investigations, calls attention to the separation of free selenium and tellurium in organisms that had been treated with these metalloids. Beyer (5) investigated this fact more closely, and proved that preparations of selenium and tellurium, in contact with living cells, are decomposed, with a consequent pigmentation of the cells, by absorbing the element.

In the meanwhile, Chabrie and Lapicque (3) showed that the microbic cell exhibited a similar relationship, their work, however, being based on mixed cultures. The most significant work was done by Scheurlen (6) and Klett (7) who closely studied the phenomenon with single, microbic individuals, *i. e.*, with pure cultures. From experiments on twenty-seven different kinds of bacteria, they conclude that sodium selenite and sodium tellurite are reduced to metallic selenium and tellurium, respectively, by growing bacteria; and are especially suitable for demonstrating the reducing properties of bacteria. Although there are differences in the extent of reduction among the various kinds of bacteria, in general, all species have the reducing power, and the intensity of reduction is, as a whole, proportional to the intensity of growth. The reducing action of the bacteria on the selenium and tellurium compounds is produced by the bacterial cell itself (protoplasm) and not by the products of its metabolism.

The work of Scheurlen, Klett and others pointed to the fact that the selenite and tellurite are mostly adapted to prove the reductive power of bacteria. They failed, however, to take into consideration that this reduction of selenium and tellurium compounds can very well serve as an indicator of bacterial life. In fact, their work would lead to the assumption that this reduction is specific to bacteria, which is not the case, for, in our work, we have found that the salts in question can be easily reduced with-

out calling bacteria into play, as through the agency of continued heat, or strongly reducing chemicals.

More recently, Gosio (8) and Belfanti (9) have made an exhaustive study of this phenomenon, particularly with potassium tellurite. While the latter confined his attention almost exclusively to the tubercle bacillus, Gosio investigated various microörganisms and the action of such media as sera, broths, milk, etc. He calls particular attention to the value of the reaction as an indicator of germ life and finds that it is most easily produced in nutrient broth and milk, while in other media in which certain albuminoids predominate, as for example, sera, the phenomenon is definitely retarded. The addition of a small amount of cane sugar varying between 0.5 grm. and 1 grm. in 100, he also found to greatly increase the sensitiveness of the "telluric reaction."

Experimental Work.

A. The Action of Potassium Tellurite on Various Microörganisms.

In our work with potassium tellurite, solutions of the salt in water were employed of such strengths that when 1 cc. was mixed with 10 cc. of culture medium, dilutions were obtained ranging from one part of the tellurite in 2,500 parts of water to one part in 300,000 parts of water. These were most conveniently prepared by taking a "stock" solution of one gram of potassium tellurite in 100 cc. of water, filtering slowly through several thicknesses of filter paper to obtain a clear filtrate, and then diluting the latter as desired. Both the commercial and Merck's highest purity potassium tellurite were used. The latter product, which is a pure, white powder, is readily soluble in water in 1 per cent. solution, and was found to be much more stable and to give uniformly better results with the various organisms.

At first, distilled water was used for the dilutions, being measured with a burette, and the solutions thus obtained were then sterilized by heating in streaming steam for an hour. However, with concentrations of the salt more than one part in 4,000 parts of water, a decomposition took place, as shown by the liquid becoming milky and the appearance of fine scaly crystals; on standing, the reagents rapidly darkened with the appearance of black flocculi. The procedure finally adopted was to take the clear "stock" solution, which is itself a germicide, and work aseptically, using sterile pipettes, dilution water, and sterile vessels. Both plain bouillon (containing 2 per cent. peptone) and 1 per cent. saccharose bouillon, as recommended by Gosio (8) were used as media, except with the tetanus bacillus, where dextrose bouillon in oil was used. Heavy inoculation was made in each case from a young bouillon culture, or an aqueous suspension of the test organism grown on suitable, solid media. Wherever feasible, a number of strains of the organism was employed in the inoculation to avoid individual idiosyncrasies. The manner of recording results is best seen

from the accompanying table with *B. coli communis*. In order to form an estimate of the most efficient strength of the potassium tellurite, the reactions obtained have been designated by the numerals 3, 2, 1, 0. In explanation, 3 signifies a strong reaction, as shown by a heavy black precipitate or flocculi; 2, a moderate reaction; 1, a faint reaction, while 0 stands for a negative result, as shown by absence of growth or coloration. Results are in triplicate, and have been recorded after a week's incubation at the optimum temperature for growth. With the exception of *B. coli communis*, the organisms studied are arranged according to the classification of Migula.

1. The Effect of Potassium Tellurite on Cultures of *B. coli communis*.

Exp't'l. numbers.	Dilution.	Medium.	Reaction.
1, 2, 3	1:2500	P.B.*	0, 0, 0.
4, 5, 6	"	S.B.	0, 0, 0
7, 8, 9	1:5000	P.B.	1, 2, 1
10, 11, 12	"	S.B.	0, 0, 0
13, 14, 15	1:10000	P.B.	2, 2, 2.
16, 17, 18	"	S.B.	1, 1, 2.
19, 20, 21	1:20000	P.B.	2, 2, 3.
22, 23, 24	"	S.B.	2, 2, 1.
25, 26, 27	1:30000	P.B.	3, 3, 3.
28, 29, 30	"	S.B.	3, 3, 3.
31, 32, 33	1:40,000	P.B.	3, 3, 3.
34, 35, 36	"	S.B.	3, 2, 2.
37, 38, 39	1:50,000	P.B.	2, 2, 2.
40, 41, 42	"	S.B.	2, 2, 2.
43, 44, 45	1:100,000	P.B.	2, 1, 1.
46, 47, 48	"	S.B.	2, 2, 2.
49, 50, 51	1:300,000	P.B.	1, 1, 1.
52, 53, 54	"	S.B.	1, 1, 1.
55, 56, 57	Controls	P.B.	0, 0, 0.
58, 59, 60	"	S.B.	0, 0, 0.

*P. B.—Plain bouillon.
S. B.—Saccharose bouillon.

As may be noted from the accompanying table, there is considerable latitude in the strength of tellurite giving the reaction. With *B. coli communis*, the typical reaction seems to be the formation of a heavy black precipitate, sometimes leaving the supernatant liquid clear, but of dark color, more often, however, diffused through the tube of the medium. (Cf. Fig. 1, #1.) A concentration of 1:30,000 of the salt seemed to give the optimum reaction, being apparent even after twenty-four hours' incubation at 37° C.

Microscopical examinations of the colon bacilli thus treated, in hanging

drop preparations, showed that the reaction produces distinct morphological changes in the bacillus. The organisms appear very much distended,

FIG. 1.

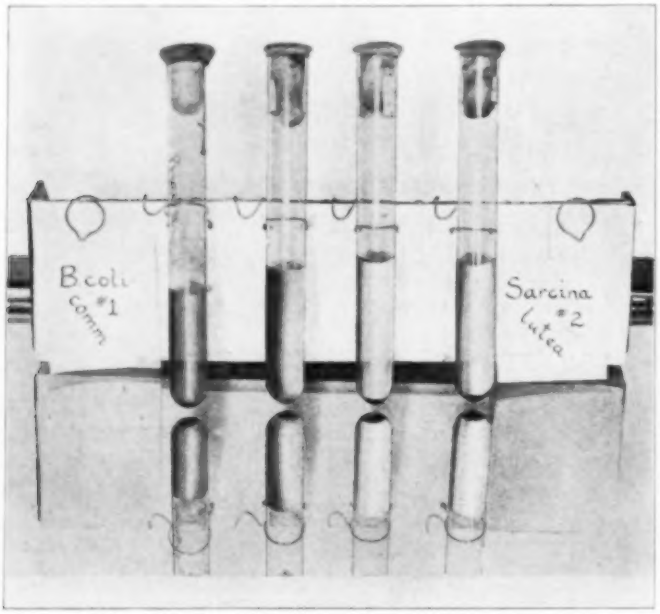
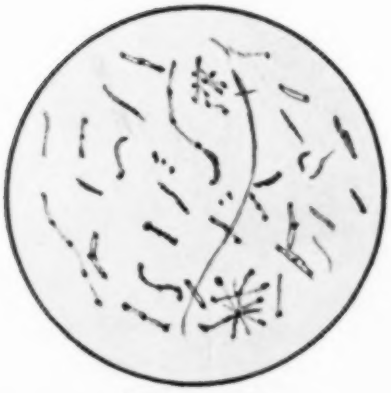


FIG. 2.



B. coli communis
Treated with Potassium Tellurite
Drawing from Hanging Drop Preparation.

some being from three to four times the normal length. Instead of being straight, many are curved, resembling spirilli. The most striking modifi-

cation, however, is the presence of black granules, resembling those of *Bact. diphtheriæ* when stained by Neisser's stain, but having from three to four granules present in every organism. Especially in older cultures showing the reaction, the bacteria seemed grouped together as if they were agglutinated. Saccharose bouillon, as a whole, did not give any better reaction than did the plain bouillon.

2. Streptococcus pyogenes.

In working with the streptococcus, a "stock" vaccine was used, containing eleven different strains of streptococci. Here again, the action was rather slow in appearing and seemed best at 1:50,000. It is shown macroscopically by a finely granular, black precipitate clinging tenaciously to the bottom of the tube, while the supernatant bouillon is usually clear and not darkened.

Examined in the "hanging drop" there is a preponderance of short chain forms, as compared with long chains in the control tubes containing no tellurite. These short chains are composed mostly of three or four black beads, with perhaps several uncolored beads where the reaction has not been completed, all of which are the normal size.

3. Micrococcus pyogenes albus.

4. Micrococcus pyogenes aureus.

5. Micrococcus pyogenes citreus.

For convenience, the above three races of staphylococci were studied together, with the view, if possible, of noting any distinctions apart from their chromogenic power. In a general way, the reaction given by both the *aureus* and *albus* varieties were quite similar, that given by the former being the more pronounced. Both, however, were rather weak. The optimum concentration seems to be about 1:100,000, although good results are obtained at 1:50,000.

Seemingly in marked contrast, a strong reaction was obtained with the *Micrococcus pyogenes citreus* in every dilution studied. It would appear that, in addition to chromogenesis, this behavior towards potassium tellurite possibly might be utilized as a means of differentiation between the varieties of the pyogenic staphylococci.

In routine procedures involving laboratory diagnosis, as in the preparation of autogenous vaccines and other manipulations, it is necessary to identify the *Micrococcus pyogenes* group with the least possible delay. Where there is relatively slow pigment formation, the use of potassium tellurite might be found to possess some value.

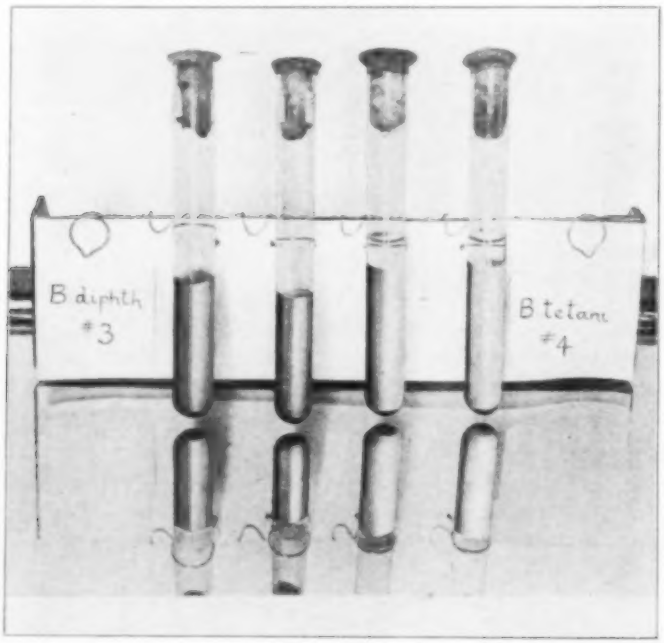
Macroscopically, the reaction with the staphylococci shows a similarity of appearance to that obtained with the *Streptococcus pyogenes*, the supernatant bouillon being clear, with a thick, viscous, black sediment. Examined in the "hanging drop," the "tellurited" organisms appear somewhat

smaller than the normal, control cultures, and are shown usually by three or four black cells, the remaining cocci in the group being unaffected.

6. Sarcina lutea.

Sarcina lutea seemed to react well with potassium tellurite, the tubes showing a characteristic granular sediment of a black mottled appearance, with the supernatant liquid clear. (Cf. Fig. 1, # 2.) Examined under the microscope in a "hanging drop," the usual cubical packets are seen, having mostly one or two uncolored cells, the rest of the cocci being entirely black. The reaction, as a whole, is rather quick in appearing, being well developed in forty-eight hours, and seems to be best at 1: 40,000.

FIG. 3.



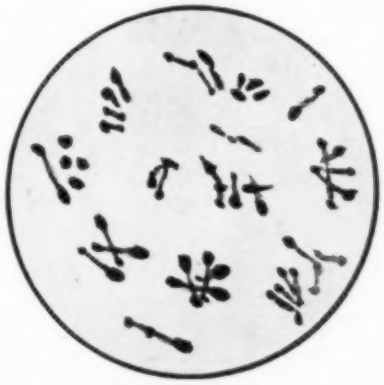
7. Bacterium diphtheriæ.

Although the "tellurite reaction" is rather slow in making its appearance with *Bact. diphtheriæ*, it is, nevertheless, very marked. In the higher concentrations, particularly 1:10,000, the appearance of the tube was almost black, with a heavy black precipitate. The most typical reaction seems to be at 1: 50,000, and is shown by a dense, black precipitate clinging tenaciously to the bottom of the tube, while the supernatant medium is cloudy, and frequently colored brown. (Cf. Fig. 3, # 3.) Apparently no antiseptic action was exerted even at 1: 2500, while 1: 300,000 also gave a good result,

indicating a wide latitude in which the "tellurization" manifests itself. This relatively great tolerance of potassium tellurite by the diphtheria organism has more recently found practical application in the differential diagnosis of diphtheria by means of the Conradi-Troch "Tellurium plate." (Cf. Wagner (10), Schürmann and Hajós (11).)

Examined in the "hanging drop," the organism studied, which was of the Wesbrook "A" type, appeared as if stained by the Neisser method. The granules were especially apparent, as were also the "V" shaped or "snapping forms," and frequent, extra large, individual cells, similar to those obtained with five hour cultures on blood serum at 37° C. On the whole, the organisms appeared much larger than when examined in a nor-

FIG. 4.



Bact. diphtheriae
Treated with Potassium Tellurite
Drawing from Hanging Drop Preparation.

mal, stained preparation, and also larger than those of the "control cultures."

8. Bacterium tuberculosis (Homo.).

In the work with this organism, the bacteria were first grown on glycerine agar, then accustomed to plain and saccharose bouillon by several transplantations. Owing to the scanty growth of the organism in the culture media employed, as shown by the "control tubes," the reaction in no case was very strong. Macroscopically, it appeared as an almost metallic, black, flaky deposit, or black ring, at the bottom of the bouillon tubes, the remainder of the medium being clear.

On microscopical examination, the "treated" tubercle bacilli showed several black granules, sometimes appearing as bipolar. Occasional branched forms, such as are encountered in the sputum of those suffering from pulmonary tuberculosis, are also found in some of the fields. The

action is very slow in making its appearance, and is not fully developed before a week's time. Here, also, a wide range in the dilutions giving the results is found, the best being at about 1: 10,000.

9. Bacillus subtilis.

As would be expected, the action is slower with *B. subtilis* than with *B. coli communis*, the first evidences of blackening appearing only after forty-eight hours. The dilution giving the best results seems to be about 1: 50,000 although the differences with the various concentrations are not as marked here as with *B. coli communis*.

Macroscopically, the action with *B. subtilis* appears as small, black clumps at the bottom of the broth tube with the supernatant liquid entirely clear and usually a blackened, wrinkled pellicle at the surface of the medium. Examined microscopically in a "hanging drop" preparation, both individual bacteria and zooglea films can be seen. In both cases, the organisms are considerably smaller than the untreated forms, and are colored a uniform black.

10. Bacillus typhosus.

Contrary to what would be expected, the results obtained with the typhoid bacillus differed materially among various strains, and especially from *B. coli communis*. On this account, we are making a special study of the "tellurite reaction" with the colon-typhoid group, the results of which we hope to report upon in the near future.

The typhoid bacillus seems to be peculiarly sensitive to the antiseptic action of the tellurite. Below 1: 50,000 there is very little reaction, while the best results are obtained at 1: 100,000. The appearance of the typical reaction is very similar to that of the colon bacillus—a powdery, black precipitate at the bottom of the tube, usually diffused through the supernatant liquid, giving it a brownish-gray tinge. On microscopal examination, however, a marked difference is apparent. The "tellurited" organisms appear about two-thirds as large as the normal typhoid bacilli, are non-motile, and instead of the four granules of the colon bacillus, these have a single, round, black granule at each pole. Occasionally an organism is seen having three such granules, while others are found considerably smaller in size and entirely black in color. The reaction is comparatively slow in appearing.

11. Bacillus abortus (Wien I).

A culture of *B. abortus* being available at the time of this investigation, it was thought advisable, in the interests of completeness, to compare the action of this organism to potassium tellurite. As was expected, the reaction with *B. abortus* was not very pronounced, owing in a great measure to the fact that the organism, itself, requires special, anaërobic cultivation. The results obtained, however, seem to justify the conclusion, that the bacillus of contagious abortion gives the "tellurite" reaction. About

1:50,000 seemed to give the best results. At this concentration, it showed as a slight, brownish turbidity with a blackened sediment in the tubes. Microscopically, the bacilli, which normally are well isolated, appear grouped together in two and threes in a row, so that at first glance they might be mistaken for darkened bacilli with several spores, or light-colored granules.

12. Bacillus prodigiosus.
Bacillus pyocyaneus.

B. pyocyaneus and *B. prodigiosus*, in mixed culture, gave a marked reaction with tellurite, particularly in the concentrations ranging from 1:5000 to 1:20,000. Macroscopically, this was shown by a decided blackening, usually diffused throughout the entire medium with a black ring at the surface, but appearing as a black sediment in the higher dilutions. Chromogenesis is not affected, as is evidenced by the fact that the tubes showing the black deposit still had the greenish fluorescence and the red ring characteristic of *B. pyocyaneus* and *B. prodigiosus*, respectively, when grown in bouillon. Examined microscopically in the hanging drop, the smaller, oval *B. prodigiosus* is found to be uniformly blackened and only slightly motile. The larger *B. pyocyaneus* appears with two or more black granules, the motility being unaffected. The reduction is very rapid, being plainly evident after twenty-four hours' incubation.

13. Bacillus mesentericus.

For *B. mesentericus*, a concentration of about 1:30,000 seems to give the best reaction with potassium tellurite, although a good result is obtained even at 1:300,000. Concentrations stronger than 1:10,000 have an apparent, antiseptic action. The reaction is rather slow in appearing, and is shown by a dark, grey-black sediment, the supernatant medium being clear.

Microscopically, the bacilli appear much smaller than normal with bipolar, black granules. Occasionally, an organism is found uniformly colored black. The motility is less than normal, and spore formation is not so apparent.

14. Bacillus tetani.

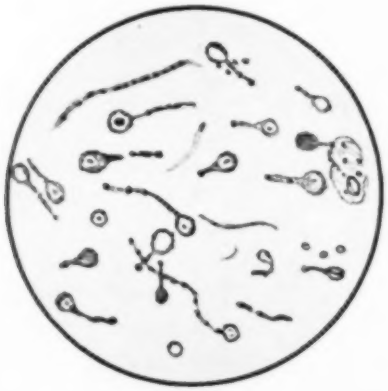
Owing to the strict, anaërobic requirements of the tetanus bacillus, the ordinary technique could not be observed. Accordingly, glucose bouillon with neutral oil was chosen as the medium, and inoculated with four drops of a good growing bouillon culture of the organism. This was then incubated for two days at 37° C. and finally potassium tellurite added, as usual, to give the various concentrations.

Unlike most of the other organisms studied, the best reaction of the tetanus bacillus was at the strongest concentration employed—1:2500. As would be expected, the reaction is slow in appearing, and is first shown by

a brown ring near the top of the culture tube. This gradually extends down to the bottom, giving a black flaky deposit, with the supernatant medium brown and turbid. (Cf. Fig. 3, # 4.)

Examined in "hanging drop" preparation, almost the first thing noticed is the decided, granular appearance of the bacillus. Exceptionally long forms, showing as many as twelve black granules are frequent, and, in some cases, show the characteristic "drum-stick" spore. The large spores, sometimes noted with this organism, are also seen, seemingly with a black spot in the centre of the spore. The reaction takes at least a week before completion, but is distinct even at 1:100,000.

FIG. 5.



B. tetani
Treated with Potassium Tellurite
Drawing from Hanging Drop Preparation.

15. Spirillum tyrogenum.

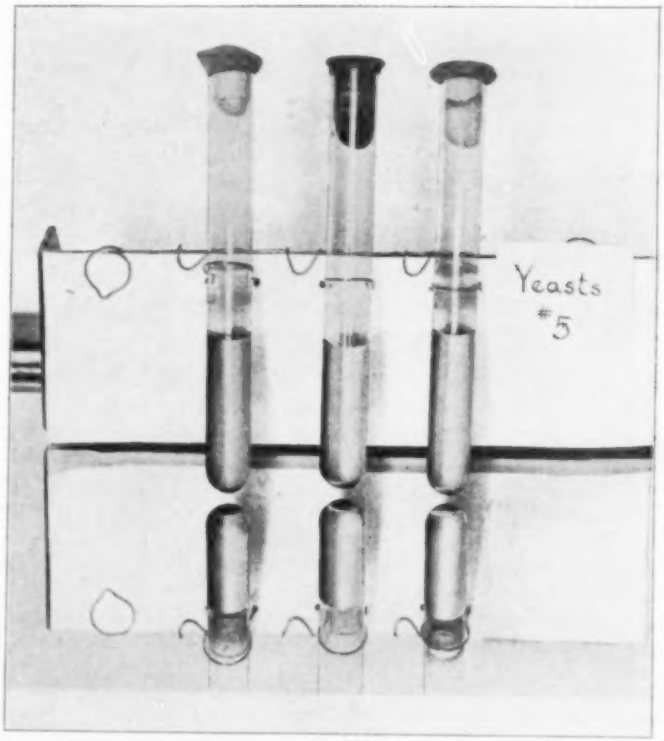
The reaction with this organism was very slow in appearing and not very marked. The tubes showing the most typical results had either small, black, granules in the sediment at the bottom of the tube, or a black ring. On microscopical examination, the spirilla were found to be smaller than normal, sluggishly motile, and colored uniformly black. About 1: 40,000 seems to be the concentration giving the best results.

16. Saccharomyces cerevisiæ.
Saccharomyces glutinis.
Saccharomyces albus.

For studying the action on yeasts, a culture was used, consisting of the ordinary beer yeast—*Saccharomyces cerevisiæ*—together with two so-called "wild yeasts,"—*Saccharomyces albus* and *Saccharomyces glutinis*. The material used for inoculation was obtained by washing off a twenty-four-hour, 20° C. agar slant culture into sterile water.

The "tellurite" action with yeasts is very rapid, being distinctly visible after incubating for eighteen hours at room temperature, which is the most suitable for growing the yeasts. With the exception of the highest dilution (1:300,000), all of the tubes showed a characteristic, heavy, black deposit, frequently extending up through the culture medium, with a black ring at the surface. (Cf. Fig. 6.) The cells of the *albus* and *glutinis* were, in most instances, found to be stained deeply black, while that of the *cere-*

FIG. 6.



visia showed black granules, the remainder of the cell being unaffected. No alteration in size or tendency towards involution forms was noticed.

17. Penicillium glaucum.
Aspergillus.

For the study of the action on molds, the bouillon tubes were inoculated with the ordinary blue-green mold—*Penecillium glaucum*, together with a variety of Aspergillus, species unknown. The incubation here, also, was at room temperature, but the reactions obtained were much stronger than

THE ACTION OF POTASSIUM TELLURITE ON VARIOUS MICROORGANISMS

Organism.	Macroscopical appearance.	Microscopical appearance.	Concentrations giving reaction and optimum concentration.
1. *B. coli communis.*	Heavy black ppt., diffused through medium. Action rapid and strong.	Bacilli larger, curved and clumped. 3–4 black granules.	1:10,000—1:300,000 1:300,000
2. *Strep. pyogenes.*	Finely granular black ppt. supernatant bouillon clear. Action slow and moderate.	Normal size, short chains. 3–4 black beads in chain.	1:40,000—1:300,000 1:50,000
3. *Mic. pyog. albus.*	Small, viscous, black sediment; supernatant bouillon clear. Action slow and feeble.	Smaller size with 3–4 black cells.	1:40,000—1:300,000 1:100,000
4. *Mic. pyog. aureus.*	Small, viscous, black sediment; supernatant bouillon clear. Action slow and feeble.	Smaller size with 3–4 black cells.	1:40,000—1:300,000 1:100,000
5. *Mic. pyog. citreus.*	Thick, viscous, black sediment; supernatant bouillon usually clear. Action strong.	Smaller size with 3–4 black cells.	1:2,500—1:300,000 1:50,000
6. *Sarcina lutea.*	Characteristic, gran. black sediment. Supernatant liquid clear. Action rapid and strong.	Normal size with blackened cells.	1:2,500—1:300,000 1:40,000
7. *Bact. diphtheriæ.*	Dense, clinging, black ppt. Supernatant liquid cloudy and brown. Action slow but strong.	Bacteria larger with numerous black granules.	1:2,500—1:300,000 1:10,000
8. *Bact. tuberculosis (Homo)*	Metallic, black, flaky deposit. Supernatant liquid clear. Action slow and feeble.	Bacteria branched and granulated.	1:15,000—1:300,000 1:10,000
9. *B. subtilis.*	Small, black clumps; supernatant liquid clear with black pellicle. Action rapid and strong.	Bacilli smaller and uniformly black.	1:20,000—1:300,000 1:50,000

THE ACTION OF POTASSIUM TELLURITE ON VARIOUS MICROORGANISMS
Concluded.

Organism.	Macroscopical appearance.	Microscopical appearance.	Concentrations giving reaction and optimum concentration.
10. *B. typhosus.*	Powdery, black ppt. diffused through medium. Action slow and moderate.	Smaller size with one black polar granule.	1:50,000—1:300,000 1:100,000
11. *B. abortus.*	Slight brownish turbidity with black sediment. Action slow and feeble.	Bacilli grouped and entirely blackened.	1:5,000—1:300,000 1:50,000
12. *B. prodigiosus.* *B. pyocyaneus.*	Black sediment, diffused through medium with black ring. Action rapid and heavy.	Normal size; *B. prod.* blackened and *B. pyocy.* granulated.	1:5,000—1:300,000 1:50,000
13. *B. mesentericus.*	Dark, grey-black sediment; supernatant liquid clear. Action slow and moderate.	Bacilli smaller with bipolar, black granules.	1:20,000—1:300,000 1:30,000
14. *B. tetani.*	Black, flaky deposit; supernatant liquid brown and turbid. Action very slow but heavy.	Bacilli larger with numerous black granules.	1:2,500—1:100,000 1:2,500
15. *Spir. tyrogenum.*	Small, black granules or black ring. Liquid above, clear. Action slow and feeble.	Org'ms. smaller and blackened. Motility affected.	1:2,500—1:300,000 1:40,000
16. *Sacch. cerevisiæ.* *Sacch. albus.* *Sacch. glutinis.*	Characteristic, heavy, black sediment; supernatant liquid blackened and with ring. Action very rapid and strong.	Normal size, *Sacch. alb.* and *Sacch. glut.* blackened, while *Sacch. cerev.* granulated.	1:2,500—1:300,000 1:50,000
17. *Penicillium glaucum.* *Aspergillus.*	Heavy, black, felted mass, extending into medium. Action very rapid and strong.		1:2,500—1:300,000 1:50,000

Average optimum concentration, 1:50,000.

with the yeasts. In almost every instance, the surface of the tube was covered with a heavy, black, felted mass, frequently extending down into the medium itself. Apparently the various concentrations had very little influence on the intensity of the reaction, as it was as marked at 1:2500 as at 1:300,000 and, in each case, appeared in twenty-four hours.

B. *General Considerations of the "Tellurite Reaction."*

As true of any "vital reaction" where chemical changes are produced through the agency of living material, both physical and chemical factors have a marked influence on the action of potassium tellurite on microorganisms. Essentially, this is a reduction from the tellurite to metallic tellurium, probably with the formation of hydrogen and hydrogenated compounds. This is evidenced by the fact that with the *Bact. tuberculosis*, not only did we find the black metallic precipitate indicative of the tellurium, but several of the tubes had a garlic-like odor analogous to the arsines, and which in all probability were hydrogenated tellurium compounds or "tellurines." Theoretically, then, the presence of saccharose in the medium as recommended by Gosio (8) should make it more easy for the bacteria to reduce the tellurium salt through the formation of special fermentation products. Our work, however, has failed to find any material advantages resulting from the use of saccharose bouillon. In fact, with *B. mesentericus*, *B. abortus*, *Streptococcus pyogenes* and *B. coli communis* the plain bouillon seemed even slightly better than the saccharose.

The presence of acids or alkalies, as would be supposed, interferes with the "tellurite reaction," the acids more so than the alkalies. This is due, not only to actual inhibitory action upon the bacteria, but also to a chemical decomposition of the tellurite, as shown by the formation of a white precipitate. Similarly, strong heat, cold, and light have both an action on the salt, and an action on the bacteria. With solid media, such as agar, addition of potassium tellurite 1:5000 to melted agar at 60° C. gave a decided brown color after solidification, while no effect was noticed when the agar was kept at 30° C.

It is also readily apparent that to obtain good results with potassium tellurite, the organism must be in an active state of metabolism. Any factor influencing the growth of the microbes will consequently influence the "tellurium reaction." The presence of dilute antiseptics, by retarding the growth of the bacteria, hinder the reduction phenomenon. In this connection, it must be borne in mind that the potassium tellurite, itself, has a relatively strong germicidal action. A germicidal assay of this salt made by our colleagues, H. C. Hamilton and T. Ohno, by the Hygienic Laboratory Method, gave a phenol coefficient of 6. For comparative purposes, an "antiseptic value" test was made at the same time by inoculating 5 cc. of the tellurite in various dilutions with 0.1 cc. of a twenty-four-

hour culture of *B. typhosus* (Hopkins) in bouillon. After forty-eight hours' contact, a subculture was planted in bouillon, and its condition recorded after forty-eight hours' time for growth in the medium. The results indicated that potassium tellurite can be used as an antiseptic in a concentration of 1: 2500, provided the organisms are exposed to the action of the solution for at least forty-eight hours.

It is evident from our results that the capacity for reducing potassium tellurite varies with the different microörganisms. Some, as for example, the yeasts, molds, and *Bact. diphtheriæ*, are especially energetic, while others, as for example, *B. abortus*, and *Spirillum tyrogenum*, gave a weaker action. Including our work with the colon-typhoid group, we have studied over twenty-five species of microörganisms. In every instance, the capacity for decomposing the potassium tellurite was present in a manner easily perceivable by the naked eye. Naturally, where bacteria are present in the spore form, no reduction of the tellurite can take place. It seems fair to assume, then, that the power of reducing potassium tellurite with the formation of characteristic black compounds is common to all microorganisms in an active state of metabolism.

The best results seem to be obtained with those organisms commonly found as sources of contamination, as the colon bacillus, the hay bacillus, yeasts, molds, and others. Therefore, potassium tellurite appears to be well adapted as an indicator of microbic life in general, but is especially suitable as an indicator of ordinary bacterial contamination occurring under practical conditions.

A general survey of the reaction with the various microörganisms studied seemed to show that an average concentration of 1: 50,000 is the most suitable for the use of potassium tellurite as an indicator. Using such a concentration of the salt, we have tested for sterility numerous aseptic, biological and chemical preparations, including sera, bacterial vaccines, alkaloidal and drug products under varying conditions. The criterion in each case was the presence or absence of a black precipitate or coloration. Controls were run at the same time, and the results checked in each instance by growing the material both aërobically and anaërobically in suitable culture media. The material was so selected or treated that about one half was actually contaminated. In practically every case, the cultural results and those obtained by the indicator were in entire agreement.

The possible application of potassium tellurite in hypodermatic products, brought up the question of its toxicity and irritating action. In experiments which were conducted by our colleague, O. E. Closson, with guinea pigs, 0.3 cc. of 1-100 solution produced marked congestion at the injection site when examination four days after. 1 cc. of 1-2000 showed locally a congestion at the end of forty-eight hours; 2 cc. of 1-5000 showed locally only a very slight inflammation at the end of forty-eight hours; 6.5 cc. of 1-15,000 showed locally no signs of the injection at the end of forty-eight

hours. Contrary to the findings of Gosio (8), the minimum lethal dose for guinea pigs at the dilution 1-2000 was 0.003 gm. per kg. Autopsy on the animals killed with the salt showed a gastro-intestinal inflammation; the site of the injection was inflamed, and had a dark deposit with a garlic-like odor.

A dog receiving subcutaneously 5 cc. portions of 1-1000, 1-2000, 1-4000, 1-8000, 1-15,000, and 1-30,000, examined at the end of forty-eight hours, showed some inflammation at the point of injecting the 1-1000 solution, just a trace at the 1-2000, and no indication at the points where the more dilute solutions were injected. A dog receiving 2 cc. portions of the same solutions, examined four days later, showed a very considerable congestion at the site of injecting the 1-1000 solution, just a trace at the 1-2000, and at the 1-8000, and absolutely none at the other points of injection.

Conclusions.

1. Nearly all of the more common microörganisms react with potassium tellurite, forming characteristic, black compounds.

2. This capacity depends on an active state of metabolism of the reacting organism, and the action is, in all probability, a reduction of the tellurite.

3. The "tellurite reaction" can be used as an indicator of microbial life, and is especially suitable for revealing microbic contamination.

4. A dilution of 1: 50,000 of the salt seems to be most suitable for its action as a general microbic indicator. In this concentration, it produces no irritative action when introduced into test animals.

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IS PELLAGRA DUE TO AN INTESTINAL PARASITE?

BONEY WELLS PAGE, A. B., M. D.,
Whole Time County Health Officer of Robeson County, Lumberton, N. C.

I wish to report for further investigation by the medical profession an animal parasite found in pellagrin feces. The parasite appears in three different forms. First, an oval form resembling an amœba but only about one-fiftieth to one-eighth the size of the latter. This trembling coccus slowly changes its position on the slide. It often changes its shape into the second form, that of a bacillus, which is capable of darting across the field and disappearing from view. Either of these forms may change into the third form, that of a spirilla, which is very active but makes little progress across the field. In advanced cases of pellagra that have had little treatment the parasite changes its form very often.

The technique for examination is the same as that for hookworm or amœba except that the oil immersion, one-twelfth is used instead of the lower powers. The parasite may be found in feces several days old.

I have found the parasite in the feces of seventeen different pellagrins examined. In two instances, the amœba was associated. In four others the hookworm ovæ were present. For the past three summers I have found the parasite in the feces of one patient, who had no clinical symptoms of pellagra except a chronic dysentery.

The prophylactic treatment, I believe, is the same as that for typhoid fever or amœbic dysentery.

The most successful treatment that I have tried in the incipient stage is flowers of sulphur, ten grains three times a day for several days. In the advanced stage, atoxyl and other preparations of arsenic render the parasite less active within a few hours. Emetin seems to have no effect on the parasite.

If this parasite proves to be the real cause of pellagra we would conclude that the disease, no doubt, is much more prevalent in the South than believed. The host of mild cases as yet undiagnosed are spreading the disease as well as those severely afflicted.

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REPORT OF COMMITTEE ON RIVER CLEANING.

Read before the Sanitary Engineering Section, American Public Health Association, Colorado Springs, September, 1913.

The Committee on River Cleaning presents the following report for the consideration of the Section. The subject assigned to this committee for an investigation is so complicated and covers such a broad field that it has not been possible to give more than a general consideration to it during the past year. There are many phases of the problem, which ought to receive thorough study, and their importance both from the point of view of the public health and the financial burdens involved, will require the expenditure of much time and considerable money. The detailed investigations upon which this committee's work will be based, must be made by municipal, state and national authorities. The committee can hardly hope to do more than to coöperate in such work and crystallize the results as they become available from time to time. In this report the committee has endeavored to set forth some general considerations and has pointed out a few of the lines along which further investigations may profitably be made. It is evident if this work is to be carried on until substantial results have been accomplished, that it will be necessary to provide for the continuance from year to year of a committee which shall devote its attention to this subject.

First of all, the term "river cleaning" does not seem to us to be wisely chosen, and we beg therefore to substitute the term "sanitary control of water ways," so that in the future this committee will be known as the Committee on the "Sanitary Control of Waterways."

As generally conceived, the pollution of waterways means the discharge into them of putrescible, infectious, or unsightly substances such as sewage or liquid industrial wastes, as well as floating solids and solids which may deposit and cause obstructions or unsightly refuse banks.

The different ways in which the pollution of waterways may prove objectionable may, for the purpose of discussion, be enumerated as follows:

(1) Persons living on or near or frequenting the banks of a polluted stream may be subjected to a nuisance resulting from foul odors, unsightly water and a foul stream bed.

(2) Public water supplies drawn from polluted streams may be dangerously affected if the water is used without purification, or if purification works are improperly operated or an undue burden is placed upon them.

(3) The value of waterways for recreation purposes such as boating, fishing, camping, or swimming, may be partially or wholly destroyed by pollution.

(4) Fish and shellfish life may be injuriously affected or destroyed by pollution.

(5) Cattle pasturing along the banks of a polluted body of water may be injuriously affected by drinking or standing in the water.

(6) Industries requiring pure water in processes of manufacture may be injuriously affected by pollution.

(7) The deposition of solids from polluting material may cause foul refuse banks and obstruct channels.

(8) Irrigation farming may be injuriously affected if the water used for irrigation is polluted either by causing a nuisance in the irrigation fields or by contaminating fruits and vegetables eaten raw.

In judging a waterway from the foregoing points of view, it is manifest that the same standards cannot be applied in all instances, nor the same devices for measuring the extent of pollution. Much of the confusion that at present exists in the popular mind, and even in the minds of sanitarians, results from failure to appreciate the impracticability of applying the same standards to all waterways. To make this statement somewhat clearer, the several aspects of the subject above enumerated will be briefly discussed with reference to reasonable requirements and the measuring devices that may be applied to determine when such reasonable requirements are met.

(1) Where it is only necessary to prevent a nuisance, and the waterway has no other practical use than that of an open drainage course, no greater requirement need be made than that the water be non-putrescible, free from unsightly color and suspended, or floating matter, and that no sludge banks or other objectionable deposits be formed. As a measure of such pollution a knowledge of the physical character of the polluting matter and the diluting water, such as color and suspended solids, together with a knowledge of its biological character, as shown by the oxygen absorbing power, would be of greatest service. Such a measure has recently been proposed by the Royal Commission on Sewage Disposal in England, and standards of this kind have been proposed for New York Harbor by the Metropolitan Sewage Commission. The perfection and general use of analytical examinations of polluted water based upon biological activity will undoubtedly prove of great service in studying the sanitation of waterways.

(2) The permissible degree of waterway pollution where such waterways are used as sources of public water supply is very difficult to determine, yet there is apparently a need for some such standard, even though it be a somewhat arbitrary one.

When such a standard is established it ought obviously to rest not upon analyses alone, but quite as much upon the sanitary conditions of the watershed as revealed by inspection, upon knowledge of stream flow at high and

low water, the population and industries tributary to the sewers, the distance of pollution above the water-works intake, and the like. In other words, some index must be obtained of the danger of infection. Nor must the esthetic sense of the community be offended by using water obviously foul.

Your committee regrets that it cannot present at this time a suitable index to be used as a standard for waterways that come within this grouping.

(3) The use of waterways for recreation purposes places a great demand upon the purity of the water, and here again the required standard is difficult to define. From a broad sociological point of view the maintenance of clean waterways, suitably located for recreation purposes, should be encouraged, for they afford cheap and wholesome recreation grounds for congested urban populations.

In establishing sanitary standards for this class of waters esthetic considerations must play a predominant part. The water must appear to be clean and there must be no sewage or wastes discharged into it that will prejudicially affect the appearance or odor of the water even in the immediate vicinity of the sewer or waste outlets. If such waterways are used for bathing purposes it is important that no untreated sewage or wastes be permitted to enter the water course, except at points so remote that self-purification is assured at all stages of the water.

(4) As to fish and shellfish life in waterways, it is interesting to note that pollution may injure or promote such life according to the nature and amount of the substances entering. When injury occurs, the permissible degree of pollution in a waterway is an essentially economic proposition, to be decided after a comparison of the damage done or expected and the cost of preventing the damage.

In the examination of waterways with reference to fish life, analyses are of special value. To support fish life water must contain certain quantities of oxygen and full information regarding this point can only be obtained by analytical means. Experiments on this subject are needed. Shellfish suffer greatest danger from comparatively small quantities of pollution matter not perceptible to the unaided senses and here rather delicate methods of bacterial analysis are needed to indicate the danger. Fish and shellfish both depend for their food supply largely upon the plankton, and in this connection a wide field is opened for the perfection and standardization of methods of analyses for determining the plankton content of waters with special reference to its value as a fish food.

(5) The question of the danger to cattle from drinking from polluted water courses should also be regarded as one to be settled upon economic grounds. For example, it may be cheaper to fence off a stream and provide a well from which water for cattle may be derived than to prevent

the stream from being polluted. It is interesting to note, however, that very many complaints against waterway pollution in rural districts arise from alleged injury to cattle and this applies with particular force to very small streams which receive the sewage discharge from small communities.

The injury resulting to cattle from drinking from polluted streams is difficult to define. About the only specific disease that may be carried through the ordinary channels of pollution is anthrax, but this is of very rare occurrence in this country. The most persistent complaint is that cattle seem to thrive poorly, grow thin and die; yet there are also many instances where cattle for many years have drunk from a polluted stream and seem none the worse for the experience. Before the extent of the injury to cattle by polluted waterways can be intelligently considered, there must be brought together more data than now exist, and inquiries along this line are suggested for the consideration of a succeeding committee.

(6) Injury to industries by waterway pollution must be considered on a strictly economic basis, that is to say, the cost of preventing the pollution and the damage that accrues to the industries from such pollution must be compared. The means for measuring pollution in such cases must vary with the character of the industries affected, and no general rules may be laid down.

(7) The obstruction of channels by solid matter as distinct from the unsightly and malodorous sludge banks is a problem that sometimes must receive consideration. Such obstructions only rarely result from sewage discharge, but may result in marked degree from certain industrial operations such as hydraulic stripping of quarries and sluicing operations. An element that may enter at times is the danger that floods may result from undue restriction of waterways by heavy deposits of wastes.

(8) A highly polluted water may be seriously objectionable when applied to irrigated fields. If such water is spread out over large areas and permitted to become stagnant it may give off offensive odors throughout a large neighborhood. This is all the more significant in the light of the fact that intensive farming methods used in irrigated areas give these areas many of the characteristics of suburban communities. A somewhat remoter danger is the pollution of vegetables and fruits eaten raw by coming in contact with polluted irrigating waters.

Ordinarily a condition of stability for irrigation waters is all that is necessary, though special cases may require a still higher degree of purity. Further study of the relation between waterway sanitation and irrigation should be made.

It will be noted that in the foregoing discussion comparatively little emphasis has been placed upon the relation of waterway pollution and

public health, but that much stress has been placed on the economic phase of waterway sanitation and it is important that this phase be most fully recognized. As a mere matter of civic cleanliness and public decency, public places and public waterways should be kept in a reasonably clean condition, but in approaching the solution of any problem involving waterway sanitation the question should invariably be asked "What is the value of the benefits derived, as compared with the cost of maintaining the stream in an acceptably clean condition?"

Broad generalizing must be avoided, for nearly every waterway is a law unto itself, varying in its remoteness from public view, in its variations between high and low water, in the accessibility of its banks, in the uses to which it may be put, and the physical condition of the water in its normal state and in other ways.

The legal control of stream pollution and the sanitation of waterways varies greatly in the different states. In order to exhibit these differences and at the same time to ascertain their relative usefulness the committee has invited the engineers of a large number of state departments of health to present brief papers discussing the operation of the laws in their several states. And the committee wishes to take this occasion to thank those who have so kindly accepted this invitation. We hope that these presentations will form the nucleus of a more detailed compendium of existing state laws on the subject of stream pollution, to be prepared during the coming year, should the section see fit to ask the committee to continue its work.

George C. Whipple, *Chairman.*
Paul Hansen, *Secretary.*
Andrew J. Provost.
Theodore Horton.
Harrison P. Eddy.

BOOK REVIEWS.

Leviathan. *By Jeanette Marks. George H. Doran Company, N. Y., and Holder and Stoughton, London.*

Leviathan strikes right from the shoulder; it doesn't mince matters that shouldn't be minced. It tells the truth. It doesn't condone or defend; it simply says yes and no. That is an accomplishment. It deals with drug addictions, morphine, cocaine, heroin and others. It places the blame where the blame belongs in three distinct places, in the following responsible order: the family physician, the druggist, and the user. When that has been said, the etiology is complete. A combination of any two makes for worse, but the fundamental facts are as stated. Read it and believe. If you don't want to believe, investigate, then you must believe. That is the worst of an unwilling truth, it hits hard.

There are many volumes to be found, "written with an object"; treating of social or economic problems; presenting views of value to the bookseller as material that will empty his shelves through the medium of a fanatic or faddist public. The message they carry is most commonly a selling average established by a gullible and ignorant public on the one hand and a mode writer on the other.

A notable exception to this variety of purpose story is Leviathan by Jeanette Marks. Here has been undertaken a portrayal of a national and international vice that, though more or less commonly known, has been almost completely neglected for too many generations. In Leviathan may be found the etiology, the symptom-complex and the cure— a rare combination, too rare in stories of social reform as well as in medical treatises. The authoress has been brutally frank, so frank, indeed, that she will scarcely gain credence, but at the same time so technically correct that the unbiased medical man undergoes a keen enjoyment in the perusal of her work.

It is a common criticism that the altruistic exponent of any social or economic problem handles his subject with either venom or ignorance. Neither of these criticisms may be made of Leviathan.

Every practicing physician, every health officer and every thinking man and woman could gain a true insight and, indeed, a very profitable knowledge of this greatest of all social problems from this work.

This country and the civilized, that is to say the sanitary, world has been, and to good effect, lamenting over and fighting tuberculosis; an army of workers have joined hands against John Barleycorn; a multitude have assailed the factors which unite to raise our infant mortality, yet the "greatest of these," the most insidious of all our moral sores and public maladies has been left to a few courageous knights of the pen among whom the authoress of Leviathan must be mentioned early. They have borne a lonesome burden for the common weal.

It is furthermore refreshing in the extreme to find, in lay writers, a correct scientific technique and a true insight into a situation as closely associated with a profession known for its mystery and probity (?) as Miss Marks has shown in her wonderful work.

C. E. Terry.

The Microscopy of Drinking Water. *By George Chandler Whipple, Gordon McKay Professor of Sanitary Engineering, Harvard University and the Massachusetts Institute of Technology. 3d edition, xxi+409 pp. John Wiley & Sons, 1914. $4.00 net.*

The appearance of a new edition of Professor Whipple's excellent book should be most welcome to all those who are actively engaged in the examination and control of water supplies or in the scientific and theoretical problems connected with this branch of sanitary engineering. For several years the earlier editions have been regarded as au-

thoritative, and Professor Whipple is recognized as the master in this field in America. The new edition makes his position still more secure, for the book has been practically rewritten, revised wherever modern investigation and recent literature have supplied new data of value, and enlarged by the addition of several new chapters. Of these chapters XIV, XVI, and XVII, dealing respectively with Soil Stripping, Copper Treatment for Algae, and Purification of Water Containing Algae should receive special mention.

Another new chapter, written by Dr. J. W. M. Bunker, on the Microscope and Its Use, and Photomicrography, has also been introduced.

This chapter gives the usual suggestions supplied by the manufacturers of microscopes for the care, use and manipulation of the instrument and its accessories, and will undoubtedly aid those who undertake the examination of water without having had previous experience or training.

In general treatment the book is divided into two parts: Part I deals with the methods and the application of microscopical examination of water as well as with those practical phases of treatment of water supplies which Mr. Whipple has employed in his long and distinguished experience as a biological engineer. A brief historical survey is followed by a concise statement of the objects of microscopical examination, and clear and excellently illustrated descriptions of the methods to be used. Then follows the chapter on the Microscope. Chapter VII, on Limnology, presents the subject of water study as a separate science, and deals with the properties of this medium in a particularly definite and instructive manner. The treatment here is particularly interesting and the viewpoint new and broad, data being correlated and digested instead of presented merely as isolated and unrelated facts. The four following chapters (VIII, IX, X, and XI) present the most important facts as to occurrence and distribution of microörganisms in water and the agencies influencing their development and presence. The subject of Odors in Water Supplies is exhaustively treated in Chapter XII.

The remaining chapters of Part I, constitute the bulk of the new material already mentioned and are uniformly excellent. Written after an abundant practical experience they are sure to be of great service to Sanitary Engineers and Water Works Managers.

Part II gives detailed descriptions of the organisms encountered in water supplies. These descriptions are undoubtedly the best that have ever appeared and are logically arranged. Brief but clear statements regarding classification of organisms make this portion of the book especially valuable, and only the highest praise can be given to it.

A particularly noteworthy feature of Part II is a series of nineteen plates reproduced in color, illustrating the principal types of algæ, both blue-green and green, diatoms, fungi, protozoa and other animal forms occurring in water supplies.

The originals for these figures were drawn by Mr. Whipple himself and in general show very clearly the differentiation in form and pigment distribution. Unfortunately the process of reproducing the author's sketches has failed to give true color values in many cases, but the differentiation is nevertheless so well marked that the plates will be of immense service to the student in recognizing the organisms. The whole work is careful, well arranged and thorough, and the book singularly free from errors in type or text. The reviewer wonders if the name of Prof. W. G. Fowler appearing on Page 220 should not be Prof. W. G. Farlow.

Illustrations by diagrams, photographs and photomicrographs are of unusual excellence and the Tables are exceptionally fine.

Only praise can be accorded a volume which is so clearly a masterpiece.

S. C. Prescott.

Rearing an Imperial Race. *By Charles E. Hecht, M. A., containing a full report of the Second Guildhall School Conference on Diet Cookery and Hygiene, with Dietaries; Special Reports from H. M. Ambassadors Abroad; Articles on Children's Food Requirements, Clothing, etc. Demy 8 vo. cloth, gilt, 7s, 6d, net. The St. Catherine Press, 3½ Norfolk St., Strand, London, 1913.*

Fully as informing as a set of text-books on dietetics, home and school life, and hygiene of children, will be found the collection of papers on these related subjects presented in Rearing an Imperial Race, which gives the deliberations of a notable English conference held at London in June, 1913.

The desire of foreign students to ascertain the effectiveness of the English and Scottish Education Acts (Provision of Meals) furnished the *raison d'etre* of this conference, and its further justification is found in the dissemination of clear ideas and sound knowledge which the printed record accomplishes in an admirable manner.

Stress is laid on the provision of meals for under-nourished school children. The refreshing and inspiring note of the discussion is manifest in the frankness which characterizes it throughout.

The point is made that often the social and educational aspects of the school meal are not sufficiently emphasized. To overcome this deficiency, it is suggested that the service of food prepared by the pupils themselves should be utilized as an educational instrumentality.

The theory of school feeding lacked no support. It was asserted that a well organized scheme of school feeding was a formidable force in the battle against tuberculosis and malnutrition which often lie "at the root of much preventable physical suffering, inefficiency and death."

To the student of the school lunch, not the least important of the dissertations is that of Mr. Nicholls, who traced with great clarity the genesis of the school lunch movement in England. He reiterated the well-known recommendation of the 1903 inter-departmental committee on physical deterioration, that "no purely voluntary association could successfully cope with the full extent of the evil" of malnutrition, the three cardinal causes of which were attributed to (1) the want of food, (2) the irregularity with which children get their meals and (3) the unsuitable character of the food when they get it.

Then in a most illuminating manner, Mr. Nicholls gives some administrative details of school feeding and the experience of other countries which the student of this problem cannot afford to miss.

That the teaching of hygiene be made compulsory was the keynote of another notable contribution to the congress. Closely related to the practical application of courses of hygiene is the subject of clothing of school children. A clarion call for a crusade in this field was sounded by Dr. Alice M. Burns, who said:

"Most of the minor defects which arise in school life as the result of wrong habits of breathing and bad habits of posture—the presence of adenoids and hypertrophied tonsils, lateral curvatures, round shoulders, contracted chests and all the varying degrees of lung impairment which owe their earliest initiation to the stultifying, deteriorating effects of an imperfect thoracic development —would be materially diminished both in frequency and degree by the advent of a universally adopted rational school outfit."

There seemed to be a general feeling that infrequently the teaching of hygiene is not sufficiently linked with its actual practice. "The hygienic conscience seems to be acquired almost unconsciously if the environment is uniformly hygienic. The only rational order appears to us to be—live hygiene—learn hygiene—teach hygiene," says Mrs. E. Adais Impey.

The discussion of the subject of rural school hygiene stressed the fact that the physical condition of suburban scholars was in a more precarious state than that of urban children. This statement is especially significant to us here as it verifies the recent findings of the special committee of the National Education Association (Dr. T. D. Wood, chairman), in which it was declared,

after a careful survey of the physical condition of school children in the rural districts of a number of states, that the percentage of defects is on the whole higher in the country than in the city.

A plea was made for a more adequate inclusion of the related topics of Domestic Science in the school life of the girl. Quite incidentally, the discussion brought out the urgent need of lengthening the compulsory school period from fourteen to sixteen years, a principle already being actively urged by the National Child Labor Committee in our own country. This, it was alleged, was necessary in order to better prepare children for the stern and uncompromising realities of life.

Among other things the following topics are also discussed: Diet; Cookery; Hygiene under the Provision of Meals Act; The Administration of the Act; Social and Educational Aspects of School Meals; Life and Diet of Primary Scholars; How Far is Feeding of Children an Educational Function; Teaching Personal Hygiene in School; Teaching Cookery; Open Air Schools; Diet of Country School Children; Malnutrition—its Causes and Consequences; Clothes and the Child; Institutional Housekeeping.

The volume recalls what Lord Beaconsfield once said:

"The health of the people is really the foundation upon which all their happiness and all their powers as a nation depend; but if the population of that country is stationary or yearly diminishes in stature and strength, that country is doomed."

Edward E. Brown.

Superintendent, Bureau of Welfare of School Children, New York Association for Improving the Condition of the Poor.

The Source, Chemistry and Use of Food Products. *By E. H. S. Bailey, Ph.D. P. Blakiston's Son & Co., Philadelphia. Illustrated. 517 pages. Price $1.60 net.*

In this book we have included an account of the production or manufacture of various foods, essential statistics relating to them, an elementary characterization of their composition, and a body of hygienic doctrine. These have been brought within a moderate compass with remarkable success. The best authorities are freely cited. The style is clear and agreeable. Almost anyone will gather interesting information by the most casual browsing and the attractiveness of the presentation will hold him to his reading longer than he intended. The well-chosen and unfamiliar illustrations are most helpful.

The discussion of the values of different foods for human nutrition is free from dogmatic assertions and temperately conducted. The economic necessity rather than the assumed danger of preserving foods by all possible methods is properly emphasized. A careful distinction is made at every point between injurious defects of food and those which are merely fraudulent. The book can be unreservedly commended.

Percy G. Stiles.

HEALTH DEPARTMENT REPORTS AND NOTES.

REPORTS.

Calgary, Alberta.

The annual report of the Department of Health of the city of Calgary lends itself well to popular education in health matters and public instruction in the work of the local authorities. The report of Medical Health Officer S. Mahood is especially creditable from the standpoint of educational work. A remarkable spirit of progress and activity is manifested throughout.

Among the more important improvements introduced during the year are a baby milk station, dairy inspection, a city laboratory, a new refuse incinerator, and some new sanitary laws. Recommendations for improvement include an amplification of the isolation hospital with provision of a unit system for different diseases, since there has been trouble with cross infection; the employment of a visiting nurse to assist the bureau of tuberculosis; the continuation of the baby milk station during the whole year; the introduction of general educational work regarding venereal disease; a law requiring birth reports within twenty-four hours; a new water supply or filtration; a housing survey; and free public baths.

That the work of the department has been effective is indicated by a drop in the death-rate from 14.29 in 1912 to 11.86 in 1913, while the infant mortality rate also decreased from 173.0 to 130.0 per thousand births. The latter is attributed to the work of the baby dispensary and milk station and the work of the infant hygiene nurse. During the summer months when the milk station was in operation there was a decrease of 55 per cent. in the rate. The control of the milk supply is being made much more complete by inspection of dairies and creameries and by taking samples and excluding bad supplies. The contagious disease situation also shows general improvement, but medical inspection of schools is pointed out as being essential to the complete control of children's diseases.

As to the form of report a financial statement and the International System of classification of deaths are among the desirable improvements.

Lynn, Massachusetts.

The Board of Health of Lynn presents a well prepared report for the year 1913. Lynn has a population estimated at 95,000 and a considerable percentage of foreigners. In view of the somewhat unfavorable sanitary situation, as it would naturally exist, the death-rate of 11.92 is an extremely creditable figure, and the fact that it is below the Massachusetts average may be set opposite the fact that the annual per capita expenditure ($1.21, including refuse disposal and hospitals) on health work is considerably above the mean expenditure in the state.

Improvements in equipment and methods introduced during the year include more thorough inspection of public eating places and enforcement of the rule that all, including the lunch carts, be connected with water and sewer; appointment of a veterinarian as inspector of slaughtering animals with consequent removal of this work from the province of the milk inspector who has also been supplied with an automobile and has thus been enabled to make more frequent inspections of dairies, stores, and milk rooms; additional room in the tuberculosis sanatorium and hospital for contagious disease; in the schools, the establishment of special clinics for the treatment of disorders of the eye, ear, throat, nose, teeth, and skin, and enforce-

ment of compulsory vaccination on the basis of the belief that no permanent cause for exemption is recognized; inauguration of a campaign of popular education by a series of bi-weekly lectures in the high school auditoriums, "covering the entire field of hygiene," for the benefit of parents and teachers, and the exhibition of lantern slides with accompanying lectures in the moving picture houses.

Recommendations for further improvements include increased provision of better service for waste collection and disposal; an increase in the interest of citizens in the appearance of the streets, the installation of at least three comfort stations in the city; transfer of the granting of licenses for public eating places to the board of health; additional hospital accommodations for contagious disease; and the employment of additional school nurses.

The report of vital statistics gives some very interesting tables; the comparison of conditions during recent years being unusually complete. No figures on births during the year are printed and the infant mortality rate is omitted also. The classification of deaths by causes might also be made more complete with good effect and without using additional space. Reports of employees, other than that of the city physician who is a member of the board of health and those of the medical inspectors of schools, are almost wholly statistical and would be much more valuable if they were made instructive rather than formal.

DEPARTMENT NOTES.

Culture Incubators in Police Stations.

In the September issue of *The Modern Hospital* Commissioner Young of the Chicago health department tells of the Chicago plan of using the police stations as culture stations. The plan is successfully used in other cities and is in many ways preferable to the drug store culture station system. We quote a part of Dr. Young's remarks:

"In handling diphtheria cultures, it has for a number of years been the practice of the Chicago health department to make use of the police stations as points of collection for diphtheria culture tubes, and of the police messenger service as a means of transportation from these points to the laboratory. The enormous area covered by the city of Chicago made some such method imperative; otherwise delays of a day of two might easily result from the time the culture was made to its being received at the laboratory, it being entirely impossible for the department to finance any system of collection from drug stores or other points of deposit. This method proved quite satisfactory, but still involved considerable delay between the time of taking the specimen and the time that it could be placed in an incubator in the department.

"In the fall of 1913 the department determined to install incubators in all the police stations. We accordingly purchased forty-one electrically operated incubators (Fig. 1), each with an inside measurement of 10 x 10 x 10 inches, and two incubators 24 x 18 x 17½ inches inside measurement. The price of the small size was $15 and of the large size $45.

"We installed one of the small size in each of the police stations, except two stations where the character of the neighborhood and the size of the district necessitated the use of the larger size. The incubators were installed in such a way as to present a neat appearance, and are kept in accurate operation by means of an inspection service.

"The messengers make from one to two trips a day from each police station to the city hall, depending on the amount of business done by the precinct. As the hour at which the culture is received at the police station is stamped on the package, the clerk receiving the cultures at the laboratory is able to tell at a glance whether a further incubation period is necessary. In a large majority of instances no further time is necessary, and it is possible to pass the specimens on to the bacteriologists for examination as soon as they are received."

Requirements for Public Health Nurses.

The Public Health Council of New York state, organized under the Laws of 1913, issues the following statement:

"In regard to the public health nurses, the law provides that:

"The commissioner of health, whenever he may deem it expedient so to do, may employ such number of public health nurses as he may deem wise within the limits of his appropriation, and may assign them from time to time to such sanitary districts and in such manner as in his judgment will best aid in the control of contagious and infectious diseases and in the promotion of public health.

"For supervising public health nurses the Public Health Council has established the following qualifications:

"1. They shall be registered nurses;

"2. They shall submit evidence, satisfactory to the Public Health Council, of training and experience of not less than two years after graduation, in one or more of the following lines of work: a, maternity work; b, infant welfare work; c, social service; d, tuberculosis work; e, care of communicable diseases, and f, school nursing.

"3. They shall be, when appointed, not less than twenty-five years of age.

"For public health nurses (other than supervising nurses) it is provided that:

"They shall be registered nurses twenty-one years of age at the time of their appointment."—*The Dietetic and Hygienic Gazette*, September, 1914.

The Making of Health Officers.

The following article by Assistant-Surgeon General Trask is clipped complete as it appears in *Public Health Reports* of September 4. The idea suggested is already carried out to some extent by the state health authorities of Kansas and New York but hitherto has not been systematized as Dr. Trask suggests nor come into very general popularity since the greater part of the work offered in both states consists of laboratory and class work instead of correspondence courses and the average underpaid health officer cannot afford to give up a week of time and the expense of traveling to the work.

"In the United States at the present time one of the greatest handicaps to rational and effective health administration is the lack of knowledge of public health work and of the control of disease on the part of many local health officials, and especially those of small cities, villages, and rural communities. This lack of knowledge is in most instances not due to unusual ignorance but rather to the fact that there are exceedingly few men with requisite training from among whom the thousands of local health officers can be appointed.

"It would seem practicable, however, for the state health department, through a correspondence course, to give a very serviceable and quite satisfactory course of instruction to its local health officers. It would be possible in this way to use in villages and townships men who had had no medical training but who, after a year's correspondence course, would perform the duties of township or village health officer in a way superior to previous incumbents. Such a correspondence course might be arranged by the state health department sending out each week to the local health officers of the state a printed or multigraphed lesson on some single point in the control of disease. Such a lesson should not be so long that it would tax the patience or the limits of concentration of the health-officer students. It should cover but a single circumscribed topic, so that each week the local health officer would learn some definite thing which would be useful to him in his work. The time taken for such a lesson would not be great. Lessons could be sent out at weekly intervals and thus spaced they would not crowd each other nor obliterate those previously learned. In a year's time the health-officer student would have learned fifty-two lessons and would have mastered fifty-two ideas regarding the control of disease. Most local health officers would in the course of one, two, or three years' instruction in this way become competent and efficient, and superior to most of those at present obtainable. Not only that, but those without previous medical training would, in townships and villages, become probably more efficient and satisfactory health officers than some of the physicians who are holding these

positions at the present time, for the medical man without other training, be he never so capable as a physician, knows but little more about the community control of disease than the person without medical training. The nonmedical health officer would eliminate, too, the embarrassing complications arising from the unfortunate custom of making practicing physicians health officers in villages and rural districts where, in performing their official duties, they are placed in the position of interfering with the practice of competing practitioners.

"Not only would such a correspondence course improve to a large degree the efficiency of local health officers, but it would constitute one more link to bind the various health units into an effective health organization.

"In carrying on such a school it would be highly desirable to hold examinations at the end of the year on the lessons that had been sent out during the previous twelve months. These examinations could be held on the occasion of the annual conference of the local health officers of the state. Those passing a satisfactory examination might be given a certificate. The course should be progressive, each year taking up new subjects. The subjects treated the first year would serve for beginners year after year. The health officer who had taken the course for several years, had passed satisfactory examinations, and held certificates to that effect, would naturally make a much better health officer than those who had not had the course. Preference might be given to those holding such certificates.

"The purpose of a correspondence course of this kind would be to have those acting as local health officers in small communities acquire some knowledge of public health administration without effort and without perceptible labor. There would, however, be many who would become interested and wish to go deeper into the subject. For these a well-selected course of reading would be an invaluable supplement to the primary correspondence course. For those who undertook the reading course there might be available periodic (annual probably) examinations on the subjects dealt with in the volumes included. The satisfactory passing of this examination should naturally receive proper recognition, and a special certificate or diploma might be issued.

"Undoubtedly many persons other than health officers would desire to take these correspondence courses because of their educational value. It would seem to be desirable to encourage this, and those thus taking the courses and passing satisfactory examinations might upon request be enrolled as members of a State Sanitary Reserve Corps. The members of such a corps would be frequently found of service and their enrollment would markedly add to their interest in local health affairs. They would be a source of strength to local health departments."

The Employment of Full-time Executive and Supervisory Medical Officers.

The following executive order, which is destined to have a far-reaching influence on the future organization and administration of the Department of Health, has been promulgated:

"Directors of bureaus who are in receipt of salaries of $5,000 or more per annum, and assistant directors of bureaus, assistant sanitary superintendents, chiefs of divisions, and all other medical officers who are in receipt of salaries of $3,000 or more per annum, are hereby declared to be full-time officers of the department, and, as such, are required to give their services to the department during the full working day.

"They shall not be allowed to engage in the general practice of medicine, or any other regular occupation or business. With the approval of the commissioner, they may be permitted to engage in public health work outside of the department, but the department retains the right to determine whether such outside work interferes with, or is prejudicial to, the proper performance of department duty, and, after due notice, may withdraw such permission at any time.

"A reasonable period (but in no case longer than four months from the date of the promulgation of this order) will be granted to men now in the service of the department to adjust their affairs to meet the requirements here stated." This executive order takes

effect September 1, 1914.—*Bulletin of the Department of Health of New York City*, August 22.

Chicago School of Sanitary Instruction.

Another plan for public health education is noted in the *Bulletin of the Chicago School of Sanitary Instruction* for August 29, as follows:

"Not least among the activities of the department of health is the work which is being carried on in the School of Sanitary Instruction.

"Since June 22, 1914, nearly fifty students from the Medical Department of the University of Illinois have enrolled for selective courses in the school, others being added from time to time; the students to devote three hours' time to the work selected, on Mondays and Wednesdays each week from 9 a. m. to 12.

"The students of the school are permitted to divide the time among such courses as they choose, some giving part of the time to work in the sanitary bureau, some to the laboratory, others to the contagious disease division or the food bureau at their own discretion, and again others taking the work in all of the bureaus of the department.

"The purpose of the school is to give those who desire an insight into the methods of public health work and to better fit them for a wider service in their professions. It should be explained that the courses are not confined to medical students, but are open to any who may desire to take them.

"A diploma is awarded to each student completing the course; and it is felt that the field of preventive medicine, into which channel the department directs these students' activities, will be enlarged in scope and usefulness, thus leading to the betterment of community conditions generally.

Canadian Treatment of Tuberculous Dairy Cattle.

The *Regina Health Bulletin* prints in its July issue the regulations of the Dominion Department of Agriculture respecting tuberculosis in dairy catalogue. The regulations lay down the plans for inspection and licensing of dairies and the conditions under which the department will coöperate with a town or city in furnishing inspectors. We quote the section dealing with the disposal of cattle reacting to the tuberculin test, since this question is a problem in many countries.

"Following the examination and test, the diseased cows and reactors shall be dealt with as follows:

"(a) Cows which in the opinion of the inspector are affected with open tuberculosis and are distributing the germs of the disease through the milk, faeces or sputum, shall be sent to an abattoir under inspection and there slaughtered as soon as conveniently can be done. When no such abattoir is within reasonable distance, the cows shall be slaughtered in the presence of the inspector, who shall direct how the carcass shall be disposed of.

"(b) Reactors to the test shall be separated from non-reactors as effectively as possible (suspicious animals shall be classed as reactors), and the owner shall be given the choice of disposing of them in one of the following ways:

"(1) Immediate slaughter.

"(2) Slaughter after they have been prepared for the block, by drying off and feeding.

"(3) Retaining them in the herd, and selling no milk or cream until it has been pasteurized.

"Compensation shall be paid to the owner of the herd for all cows slaughtered under these regulations upon the following basis:

"(1) One-half the appraised value of the cow if destroyed as a case of open tuberculosis.

"(2) One-third the appraised value of the cow if destroyed as a reactor at the request of the owner.

"(3) Valuation shall be made by the inspector, and shall not exceed the maximum valuation for cattle as specified in section 6 of the Act.

The salvage from the carcass shall be paid to the owner of the cow in addition to the compensation, provided compensation and salvage together amount to less than the

appraised value; if more, the surplus shall be paid to the receiver general.

No compensation shall be paid to the owners unless, in the opinion of the minister, he assists as far as possible in the eradication of the disease by following the instructions of the inspector as to disinfection, etc."

The Milk Standard in England.

The *Medical Officer* of September 5 contains the report of a special sub-committee appointed by public health committee of the Lanarkshire County council to consider the question of milk prosecutions under the Sale of Food and Drugs Act. A large amount of work has been done already and while the work is not completed the following conclusions have been given out:

"First—In an ordinary herd individual cows do give milk containing less than 3 per cent. of fat.

"Second—The frequency with which this occurs depends to some extent on the milking intervals and the efficiency of the milking.

"Third—The number of cows consistently giving milk containing less than 3 per cent. of fat is very small.

"Fourth—In the usual method of distribution there is a possibility of a quantity of milk being sent off from the farm containing less than 3 per cent. of fat.

"Fifth—This possibility would be removed if the milk of the whole herd were mixed together. The average quality of the milk of each herd was always above the standard of 3 per cent. of fat."

Street Cleaning and Public Health.

Municipal Engineering for September contains an interesting discussion of modern methods and results in street cleaning. The article considers the advantages of various kinds of pavement, the effect of street dust on the public health and comfort, and the methods of street cleaning now in use. Although opinions differ as to the immediate effect of street dust on public health, it cannot be denied that it is more detrimental and a greater nuisance than smoke which is receiving the attention of many health authorities. The fact that a city department is responsible for the street cleaning apparently makes action by the health department difficult, but certainly it is a matter worthy of serious consideration.

It is concluded by the author that wet cleaning is greatly to be preferred to dry and that machine cleaning is more efficient than hand cleaning although hand cleaning has its place.

"The system for cleaning streets of the future will be a combination of dry and wet methods; machine work at night and hand broom in the day time. White wings will only be used to remove coarse litter; the machines will take care of the dust."

PUBLIC HEALTH NOTES.

Report of British Committee on Bacteriological Examination of Water.

The new committee of the Royal Institute of Public Health, which was appointed to draw up a scheme of uniform procedure for the bacterioscopic examination, has just submitted its report. The report is published complete in the *Journal of State Medicine* for September. It says in introduction:

"The committee, having given careful consideration to the terms of their reference, are of the opinion that it is inexpedient to lay down hard and fast rules as to the number and kind of tests to be employed, as circumstances alter cases, and the procedure best adapted for one class of water may not be equally suitable for other waters. In all cases, however, the number of bacteria present in water should be estimated and the number of *Bacillus coli*.

"For these estimations, however, as many as possible of the following tests should be employed:

"(1) Number of microbes per cubic centimeter in (a) meat broth gelatin (or, when the climatic conditions render it necessary, meat broth agar), incubated at 20° to 22°C.; (b) meat broth agar incubated at 37°C. (Brands Essence of Beef or Lemco may, if desired, be substituted for meat broth in the preparation of these media (a) and (b); (c) lactose bile salt agar (Mac Conkey), incubated at 37°C. The medium may be tinted either with litmus or with neutral red according to the taste.

"(2) Bacillus coli test. In certain cases it is advisable to apply also—

"(3) Streptococcus test.

"(4) Anærobic spore test (commonly known in England as the B. enteritidis sporogenes test).

"(5) Tests for pathogenic microbes. Test (1) (c), (3), (4), and (5) need be employed in special cases only."

The report goes on to recommend that gelatin plates be counted after four days' incubation, but that the 37°C. agar plates and bile salt agar plates be counted in twenty-four hours. For the identification of B. coli the formation of gas in lactose peptone medium and the production of indol in a peptone medium are advised; the indol to be tested by the paradimethylaminobenzaldehyde method. The committee consider that judgment as to the purity of a water should be based primarily on the quantitative estimation of lactose + indol + microbes, although this need not prevent the utilization of the results of other tests as additional factors bearing on the position.

A tendency to give up the streptococcus test is shown and limits its consideration to those streptococci which yield acid in a lactose medium. The committee holds that a water should not be condemned on the streptococcus test alone if the B. coli and other tests are satisfactory. The anærobic spore test is not considered to be as delicate as the B. coli and streptococcus tests, but there are cases where its application may yield useful results.

The appendix, prepared by Dr. J. W. H. Eyre, contains directions for the preparation of meat extract, nutrient gelatin, nutrient agar, glucose formate broth, bile salt agar, sugar media, bile salt broth, double or triple strength bile salt broth, milk, Drigalski and Conradi's medium (modified), and the solutions for the indol test.

Teeth and Disease.

"The Sixth International Dental Congress, which was held in London in August, has been followed with much interest not only by dentists but by the medical profession and others concerned with the problems of national health. The past ten years have witnessed a growing recognition by doctors and laymen of the importance of the teeth in relation to physical and even mental health and well-being. An attempt is now being made to foster systematic research into dental problems. It is agreed that a large number of disorders of the body are in origin due to defective teeth, dental caries, decay or

pyorrhœa. Whilst at present the subject of decay in teeth is fairly well understood, pyorrhœa, which is a condition of pus within the gum, still requires considerable investigation. It does not in its earlier stages manifest its presence by toothache, for instance, and the visible part of the tooth may be apparently sound; nevertheless the toxic substances of the disease may be exercising a deleterious effect on the whole body. Chronic joint affections and certain rheumatic conditions are largely of toxic origin, and the mouth is an easy source of infection. Medical men today frequently send rheumatic patients to the dentist, who in many cases provides the cure. Some striking instances of the effect of dental operations are recorded. A man who had suffered from insomnia for seventeen years had three teeth extracted; within a week he enjoyed normal undisturbed sleep. A patient suffering from eye trouble had some teeth removed and found that his eye trouble disappeared. A woman subject to mental disorder was sent by a distinguishd alienist to a dental surgeon in order that, as a preliminary to treatment, the toxic influence of bad teeth should be removed. The public, too, are recognizing the importance of teeth; in some degree this may be due to the institution of dental inspection in elementary schools. There can be no doubt that a periodical inspection of the teeth is a wise step worthy of the public consideration, and it will not be a surprise if in the near future national dental clinics are set up and state provision made therefor."—*Journal of State Medicine*, September.

Difficulties in Quarantine.

"One of the difficulties in preventing the spread of contagious diseases is that of maintaining proper quarantine. The primary purpose is to protect members of the community from acquiring the disease; if there was nothing else to consider, that wou'd be comparatively simple.

"The quarantine should be such as to give the maximum protection with the minimum of inconvenience and expense. Unfortunately medical science has not advanced to the point that enables us to act with complete knowledge. There are many diseases, such as measles, scarlet fever, smallpox, and anterior poliomyelitis, the causes and carriers of which we know nothing. Consequently we establish rules which we hope will bring about the localization of the contagion, and, for fear lest something escape our precautions, the quarantine is continued for weeks. In many instances this is entirely unnecessary, as recent investigations concerning measles indicate that the chief infectious period is probably during the coryza stage before the diagnosis has been made. Yet some three weeks must elapse before the family is released from quarantine. In some cities the authorities are distinctly skeptical in regard to the necessity of a six weeks' isolation for scarlet fever, but it is enforced. Another factor that has to be considered is that of the transmitters of the disease. When we know how diseases spread, we are in a much better position to handle the outbreak. The methods of attacking yellow fever have been revolutionized since the discovery of the carrier. As long as there are no mosquitoes to bite the sufferer and carry the contagion, the disease is not as dangerous as typhoid fever. In regard to plague, too, it has been found that the rat and rat fleas are the conveyors of the bacilli, so our efforts are directed against them.

"At present there is a general tendency to make quarantine as simple and as little burdensome as possible. No one cares to be shut away from his fellow men; but what is more important is the interference with the bread winners. Unless our laws can be modified considerably, the public must make better provision for care of the family involved."—*New York Medical Journal*, August 29, 1914.

Plumbing and Health.

Many people have curious ideas about the relation between disease and poor plumbing. This clipping from the *Journal of the American Medical Association*, for August 29, states in a very lucid manner the fallacy of these opinions:

"It is not surprising perhaps that old ideas concerning the causes of disease survive in some strata of society a long time

after these ideas have been generally outgrown or discredited. All the same it is a little disconcerting to find that typhoid fever can still be complacently attributed to bad plumbing. When we read that 'insufficient laws regulating plumbing and sanitation in Virginia, Maryland and the District of Columbia are largely responsible for the high typhoid rate and the prevalence of other diseases in the two states and the district,' and again that 'much of the fever and other forms of disease with which the health authorities are constantly wrestling is caused by noxious gases and vapors emanating from neglected or defective pipes in the homes of the people,' we are inclined to rub our eyes and ask ourselves if the education of the community is really proceeding at the pace we sometimes like to believe. The assertions quoted above, however, were reported as made at the Association of Plumbers, Gasfitters and Steamfitters which recently met in Richmond, Va., and not at a convention of health officers of physicians.

"It is hardly necessary to point out that typhoid fever—or any other fever—is not caused by bad smells, and that the small quantity of the gases of decomposition found in well-ventilated sewers has never been proved to exert any injurious effect whatever on health. A connection between plumbing and health has been shown to exist at just one point. Plumbing is of value to public health only so far as it removes human excreta from the immediate neighborhood of dwellings and so does away with the danger of fly-borne typhoid and other infection which arises from allowing infectious material to accumulate in family privy vaults. Disease germs are not found in sewer air; indeed, it is difficult on physical grounds to see how they could get there. The 'noxious gases and vapors,' so dear to the plumber's imagination, are conspicuous by their absence in all perfectly constructed sewer systems, as every visitor to the great sewers of Paris and other modern cities well knows. 'Defective plumbing' has about as much relation to public health as any other mechanical defect in house construction.

"On the financial aspects of modern city plumbing ordinances we prefer not to dwell at this time. It is a well-recognized fact that these ordinances are drawn with no uniformity in our American cities and that what is required in one city may be prohibited in another. High authorities maintain that the system of modern house plumbing which is made legally obligatory on house-builders in many places entails a large, needless and altogether unjustifiable expense. Conceivably it is to the financial interest of plumbing supply houses—or somebody—to have the required system of plumbing as elaborate and as expensive as possible.

"One feature of this situation deserves attention. It is plain that the most serious obstacle to the universal replacement in sewered towns of the dangerous privy-vault by the water-carriage system is the high cost of the plumbing. In this respect every unnecessary refinement and elaboration in plumbing outfits and legal requirements is a harm, not a help, to public health. The greatest possible simplicity and cheapness compatible with efficiency is what is needed in really 'sanitary' plumbing, not a labyrinth of traps, vents and back-vents. If the plumbing interests really wish to aid the hygienic welfare of the community they can best do this, not by insisting on still more complicated devices and 'inspections,' but by simplifying and cheapening the cost of installing and maintaining the pipes and fixtures essential for carrying off the house wastes in a speedy and inoffensive manner. Finally, let us ask this question: To what extent do the plumbing ordinances on our American cities represent the prevailing opinion of public health experts and trained health officials, and to what extent do they represent the efforts of commercially interested individuals or organizations to entrench themselves behind the active if not always well-informed desire of the people to safeguard the public health?"

Economy and Efficiency in Comfort Stations.

The American City for August contains an interesting study by D. B. Armstrong, acting director of the Department of Social Welfare of the New York Association for Improving the Condition of the Poor. Dr.

Armstrong has made a study of comfort stations, both here and abroad, and the article will prove interesting and valuable to those who have the problem of comfort stations to deal with. The article is reprinted by the Civic Press, 87 Nassau Street, New York, as one of the American City Pamphlets.

The discussion takes up the economical management of comfort stations and compares methods of operation in various cities. New York spent $52,000 during 1912 on the maintenance of the nine stations under the control of the Department of Public Works and received practically no revenue in return. Birmingham, England, on the other hand expends about £3,000 a year on comfort stations and not only pays expenses but clears a 10 per cent. profit on the investment. This is done by having a considerable proportion of pay toilets and by selling soap, combs, hair and clothes brushes and clean towels. Other cities recieve a revenue from the sale of concessions such as boot-black stands, parcel rooms, etc.

Comparisons are given on the sanitation of comfort stations, the use of the washing facilities when hot and cold water was supplied and when only cold was available, the variation in washing depending on the supply of individual towels, common towels and no towels. The use of swing doors with locks operated by the foot is mentioned as preferable to doors requiring the handling of a knob or lock; automatic flushing devices are urged also to prevent possible infection by means of the handle. Another possibility mentioned as adding to the efficiency of the station is the installation of an information bureau for the benefit of strangers.

A Salaried Medical Profession.

The *Detroit Medical Journal* of July comments editorially on the much-discussed question of subsidizing the medial profession in the interests of public health, as follows:

"Professor Vogt, in an article contributed to *Popular Science Monthly*, makes a plea for a salaried medical profession. Attention to public health, he says, presents two aspects, the one preventive, intended to preserve health, by removing the causes of disease; the other curative, and intended to restore to health those who have fallen ill. Under existing conditions he argues, the physician has no direct financial interest in warding off disease from those who are well. His efforts are therefore directed towards the cure rather than the prevention of disease. Under the present system the physician is prosperous in inverse ration to the health of the community. To this we assent. Then the writer draws the conclusion that since the physician today receives his reward from the curative side of medical practice he is not professionally interested in the prevention of disease; with which conclusion we heartily disagree. Whatever has been accomplished in the preventive medicine has been the work of the medical profession. Problems of immunity and the study of such pathologic conditions as typhoid, tuberculosis, yellow fever, have been the work of individuals in the profession and their work has been made effective only with the coöperation of the rank and file of the profession. Professor Vogt feels that were the medical profession paid by the public the matter of preventive medicine would receive adequate attention. 'Were physicians paid by the state, they would not fear the loss of income through working for the well, while at the same time attending to the ill, because the lessening of illness would not necessarily interfere with their incomes.' This view of the matter appears amusing to the physician or surgeon who is accustomed to treat the pauper with as much care and solicitude as the rich. It is doubtless if salary from the state would alter in the least the attitude of the true physician towards those intrusted to his care. Then Professor Vogt comments upon what he calls the dissatisfaction over charges made by physicians. 'It places the burden of caring for the sick poor upon the sick well-to-do because the physician must make his charges according to the net income desired.' It would be nearer the truth to say that the physician as a rule makes a uniform charge for his services and treats the indigent free of charge. From the article it is inferred that the indigent sick are cared for out of the charity of the rich, which is certainly not the case.

Any charity extended is given by the physician himself.

"It is difficult to see how the condition of either public or physician is to be improved by a salaried medical profession even if it were possible to devise a practical scheme for adjusting the salaries or persuading legislatures and civic bodies that the necessary appropriations should be made from the budgets.

"The time is ripe, however, when the individual efforts of the medical profession could be made more effective for the prevention of disease by a national health department and more adequate state and local organization."

The Sanitary Officer in War Service.

An interesting article on the war-time duties of the officer of the sanitary corps is presented in the September issue of the *Military Surgeon*. The following brief review is clipped from the *New York Medical Journal*:

"The article contains some surprises for the general practitioner who is unfamiliar with the mass of non-medical knowledge which the army surgeon must master in addition to his needful professional knowledge. The sanitary officer, it appears, is first a military officer and secondly a medical man; his responsibility is as great as that of any other officer, although the performance of his duties may be less spectacular. In addition to maintaining the health and efficiency of the troops in camp and on the march, and attending to the sick and wounded and their transportation to points where they may be patched up for duty, the sanitary officer must not only read and interpret topographical maps, but be prepared and equipped to sketch a map himself. This enables him to calculate the time required for troops to cover certain distances and to dispose of his sanitary forces accordingly. The chief surgeon should know exactly the size, location, and transportation facilities of the sanitary troops under his orders. He will ascertain the probable location of casualties, taking under consideration the terrain, time, distance, weather and climate conditions, as well as the presence of streams, wells, and other water supply, the location of buildings or shelter for wounded, the availability of wagons for their evacuation to the rear, in fact anything which may play a part in the work of the sanitary troops. The ideal disposition of sanitary units and their appurtenances, such as first aid stations, dressing stations, ambulances, field hospitals, etc., is that which enables them to be always within reach, yet never in the way. The latter is a most important point and an ill considered move may have the greatest consequences."

Recent Studies on Pellagra.

Public Health Reports for September 11 contains three reports on the studies of pellagra now being carried on by the United States Public Health Service. The first, by Dr. Goldberger, surgeon in charge of pellagra investigations, indicates that pellagra is not infectious and, as a result of studies in various institutions, says that "the inference may be safely drawn that pellagra is not an infection but that it is a disease essentially of dietary origin; that is, that it is caused in some way such as, for example, by the absence from the diet of essential vitamines, or possibly, as is suggested by Meyer and Voegtlin's work, by the presence in the vegetable-food component of excessive amounts of a poison such as soluble aluminum salts."

Dr. W. F. Lorenz reports some experiments carried on at the Georgia State Sanitorium on the treatment of pellagra by overfeeding. He says that conclusions are not warranted by the work thus far completed, but "that a generous diet seems to have a decidedly favorable effect upon the course of pellagra." Another report by Dr. Lorenz deals with the cerebrospinal fluid in pellagra and offers the following conclusions:

"1. A lymphocytosis of the cerebrospinal fluid does not occur in uncomplicated pellagra.

"2. Globulin excess of the spinal fluid is only occasionally observed.

"3. Lange's colloidal gold chloride test is uniformly negative in pellagra.

"4. The Wassermann is negative with a few exceptions. In this investigation the exceptions were moribund cases which gave weakly positive reactions with blood serum.

"5. The spinal-fluid findings would seem inconsistent with a conception that pellagra is an infectious disease of the central nervous system."

Effect of Hypochlorite on the Teeth.

An interesting letter from C. A. Jennings, a consulting engineer of Chicago, is published in the August 22 issue of the *Engineering Record* touching on a new phase of danger from the use of hypochlorite. We quote complete:

"Hypochlorite treatment of water supplies has been blamed for many real and imaginary grievances. Many of these have been the result of prejudice against this form of water treatment. Among other things that have been laid to hypo might be mentioned the killing of goldfish, the fading of the beautiful red color of roses, the causing of grass to die when sprinkled with hypochlorite-treated water, the bleaching of the pretty locks of women and the making unfit for coffee or tea of water treated with hypo.

"A recent work on occupational diseases mentions the injurious effects of chloride of lime upon the enamel of the teeth of workers in bleaching industries and plants making chloride of lime. Hypo has been used at the Bubbly Creek filter plant since August, 1908, and is bought in carload lots of 350- and 750-pound containers. Previous to 1908 I had had but little trouble with my teeth. Since that time I have averaged about three sessions of two or three weeks each, during each year, with my dentist. Many of the cavities are of the marginal type.

"My assistant, who has been with me for more than two years, has had identically the same experience. Former assistants, while in my employ, had sessions with dentists. One of my laborers, who had never seen a dentist's chair previous to working at the Bubbly Creek filter plant, had six or seven teeth filled after about six months in this work.

"I do not believe that this condition can be blamed on the air or odor that prevails here at the stock yards, which is well known. It would be interesting to learn from others engaged at plants where hypo is used in water treatment whether or not these conditions have prevailed. It is possible that many have been looking for the culprit all this time and have been investing in various mouth washes, tooth pastes and powders, whereas hypo has been the hidden danger."

Teaching Food Values in the School.

The *Weekly Report* of the board of health of Cincinnati makes the following suggestion in regard to a means of reducing the high cost of living:

"Apropos the government's investigation of the high price of food materials incident to the European war, it is a matter of no small moment that our citizens should know how to maintain the human machine and, in time of trouble, what is best and cheapest in order to keep the human parts together.

"Noted physiologists have prepared tables setting forth the needs of adults and growing children and how these requirements may be met. Little pamphlets calling attention to these needs, suggesting a variety of menus and the food value of each article, might be distributed in the homes through the agency of the board of education or the department of health. Can we not have on the class-room blackboard a short explanation of food values —say of one or two articles a week? For example: the food value of a dish of beans over pineapples.

"The government could give information with regard to all staple commodities and foodstuffs sold in packages. The manufacturer should be forced by law to label his product in terms of calories, and he should be prosecuted for selling material of a different character than the standard deposited with the Government.

"If, through the medium of the Penny Luncheon Association the schools, public health agencies and the press, knowledge regarding food requirements and values is disseminated in the homes, then no one in poor circumstances will spend his money for a can of tomatoes which is little else than flavored water.

"When the boy sees on the blackboard that the oatmeal bought for a penny has more growing and fighting stuff in it than a barrel

of pickles, it will stimulate him in getting his money's worth. The lesson will probably be reflected in the home."

Camp Sanitation in Africa.

The *Tropical Diseases Bulletin* for August 15 describes a novel method of excreta disposal which is used in Africa. The method is based originally on the plan required by the Mosaic law (Deuteronomy xxiii, 12, 13) and developed from the fact that the scrupulous Mohammedans follow this law and cover their excreta. Many will not take the trouble to dig holes for use but will use them if provided. The plan as applied to construction camps is as follows:

"A place is marked off in a field, conveniently close to the works—say, not exceeding 100 yards distant—by means of four flags. Within the square space so selected are made pits, at distances of three feet from each other. These pits measure six inches in diameter, and eight inches in depth. On one side of each pit is placed the earth excavated from it, and a piece of split bamboo two feet or so high, having a small colored rag at the end, is fixed at the same side as the piled earth. On the side nearest the works is placed, so as to preserve the sitters from observation, a moveable screen, which may be made of jungle tree branches intertwined with any foliage that will secure protection from sight. It is necessary to retain a man on duty on the site throughout the working hours. . . . He will see that defaecation occurs in the holes only. The moment a person retires, it is the attendant's business to proceed to the hole used, and remove the split bamboo—showing that the hole is not to be again used—and with the movement of his foot to throw the earth, piled as stated above, into the pit. If the attendant be too 'nice' to do this himself, there is no reason why, without much pressure, he should not be able to convince the person who has used the pit, that it is his duty to move the earth with his foot, and thus cover the excreta.

"The method gives considerable privacy, as any hole can be chosen, and any position assumed, and as the arrangement is cleanly and odorless, there is nothing to offend the sense of sight or smell of the user. It is, necessarily, not a method that can be relied on in rainy seasons, and presupposes plots of ground readily penetrable such as are found in fields that have been cultivated. The method worked in connection with any institution having arable ground at disposal, so as to use plot after plot of ground, would place excreta economically in the best possible position for quick nitrification, and enrich the ground for subsequent cultivation."

Graduate Courses in Public Health.

From the "educational number" of the *Journal of the American Medical Association* we copy the following statement in regard to graduate courses in public health:

"Graduate courses in public health have been established in connection with seven medical schools leading to a degree of Doctor of Public Health (Dr. P. H.), Certified Sanitarian (C. S.), Master of Science in Public Health (M. S. (P. H.)) or Master of Public Health (M. P. H.). The course is for one year except at the Universities of Michigan, Minnesota and Wisconsin where the course for the Doctorate covers two years. Wisconsin gives a Diploma in Public Health (D. P. H.) for a one-year course. These colleges are as follows:

MEDICAL COLLEGES GIVING COURSES IN PUBLIC HEALTH.

Name of college.	Course started in.	Degree granted.	Years in course.	Degrees required for entrance.
Univ. of Penn. Sch. of Med.	1909	Dr. P. H.	1	M. D.
		C. S.	1	A. B. or B. S.
Med. Sch. of Harvard Univ.	1910	Dr. P. H.	1	A. B. or B. S.
Univ. of Mich. Dept. M. & S.	1912	M. S. (P. H.)	1	A. B. or B. S. and M. D.
		Dr. P. H.	2	
Univ. of Wis. Med. School	1912	D. P. H.	1	M. D.
		Dr. P. H.	2	M. D.
Detroit College of M. & S.	1913	M. P. H.	1	M. D.
Univ. & Bell. Hosp. M. C.	1914	Dr. P. H.	1	M. D.
Tulane Univ. Sch. of Med.	1914	Dr. P. H.	1	M. D.
Univ. of Minn. Med. School	1914	Dr. P. H.	2	M. D.

"Better Mothers" Contest.

A variation, and a rather desirable one in theory at least, from the usual baby contests

is that described in the *Buffalo Sanitary Bulletin* of August 31:

"Arrangements are in progress for a Better Mothers contest under the auspices of the Buffalo Department of Health. The mother will receive the prize and will be judged for the care given her baby, resulting in its excellence, in physical proportion, muscular development, respiration, circulation, digestion, general intelligence and self control.

"From present indications the entry list is expected to be very large, with a keen and interesting competition. It will be open to the public.

"All mothers whose children obtain an average of 85 per cent. will receive a certificate of Proficient Motherhood. The score card of the American Medical Association will be used."

PERSONAL NOTES.

The following persons were elected to membership in the Association September 15, 1914:

George McCrary Boteler, St. Joseph, Mo.

Dr. E. W. Brown, U. S. S. *Raleigh*, via San Francisco, Cal.

Dr. Charles Chauncey Duryee, Schenectady, N. Y.

John Boyle Gordon, Buffalo, N. Y.

Dr. Richard H. Harte, Philadelphia, Pa.

Dr. Fred Johnson, Eau Claire, Wis.

Prof. Max Levine, Ames, Iowa.

Burton Lowther, Kansas City, Mo.

James F. McCrudden, Philadelphia, Pa.

Dr. William D. Richmond, Knoxville, Tenn.

W. Voorhees, Jacksonville, Fla.

The municipal officers of health in the counties of Haldimand, Wentworth, Norfolk, Brant, in the province of Ontario, have organized an association and elected Dr. Thomas A. Bertram, Dundas, president, and Dr. James Roberts, Hamilton, secretary.

The Secretary of the Treasury, on recommendation of the Surgeon-General, U. S. P. H. S., has appointed Dr. Eugene F. McCampbell, Columbus, secretary of the Ohio State Board of Health, collaborating epidemiologist, in the United States Public Health Service.

Dr. Willard J. Denno of 14 Central Park W., New York City, and Dr. Charles White Berry of 572 47th Street, Brooklyn, N. Y., have been appointed sanitary supervisors of the State Department of Health of New York.

Dr. Denno after graduating from Yale University and the College of Physicians and Surgeons of New York City, was house physician at the General Memorial Hospital and then entered into public health work, having been continuously in the Department of Health of the City of New York since 1910, where he now holds the position of assistant chief of the division of communicable diseases.

Dr. Berry graduated from the College of Physicians and Surgeons in 1896 and since 1898 has been a medical and sanitary inspector in the Department of Health of the City of New York. Dr. Berry has also had considerable experience in military camps, as a surgeon in the National Guard, and he is now a captain in the Fourteenth Infantry.

Dr. William T. Power of 152 Greenwich Street, New York City, has been appointed lecturer on diseases and disorders of the eye, in the State Department of Health. Dr. Power graduated from Detroit College of Medicine and has made special studies of eye diseases in the clinics of the New York Eye and Ear Infirmary and of the University of Vienna. He has taught ophthalmology in the University and Bellevue Hospital Medical College, and more recently in the New York Post-Graduate Medical School and since 1905 has been assistant ophthalmic surgeon to St. John's Hospital, New York City.

Mr. Charles Saville has resigned from the firm of Hering & Gregory, consulting engineers, New York City, and will spend the coming winter in Boston, taking a graduate course at the School for Health Officers of Harvard University and the Massachusetts Institute of Technology. His address will be Waban, Mass.

INDUSTRIAL HYGIENE AND SANITATION.

Experimental Researches in Methyl Alcohol Inhalation.

The following clippings are a partial quotation from an article in the *American Medical Journal* for September 12, 1914, entitled "Experimental Researches in Methyl Alcohol Inhalation," by H. H. Tyson, M. D., and M. J. Schoenberg, M. D., of New York. Since methyl alcohol is so widely used in various industries, the question of those working with it being poisoned and even worse, blinded, becomes a problem of industrial hygiene.

"Notwithstanding the earnest efforts of the ophthalmologists and the various committees for the prevention of blindness, to disseminate the knowledge of the poisonous qualities and effects of methyl alcohol, it is still a lamentable fact that many members of the medical and legal professions and the vast majority of the laymen, especially the workers using it, are either ignorant of or do not acknowledge the truth. The effect on the eyes and general health from drinking wood alcohol has been proved experimentally in animals, and has been corroborated in clinical practice; but the effect from its inhalation alone on the eyes has never heretofore been demonstrated experimentally.

"Although many clinical data have been collated tending to show an effect similar to the one obtained from its imbibition, many doubt and some dispute its power to effect the human organism deleteriously through inhalation alone. The wish to prove this fact, coupled with a desire in the interest of humanity to lessen the number of the blind and to conserve life, by advocating proper preventive or precautionary measures for workers using it, induced us to undertake these experiments. . . .

"The manufacturers assert that even admitting that commercial wood alcohol is poisonous, the refined product known as Columbian Spirits is not. We have proved conclusively that the refined spirit is quite as dangerous as the unrefined; and indirectly more likely to destroy vision and life on account of the absence of the disagreeable odor to warn one of its presence."

"The contentions of the manufacturers that the refined methyl spirits are absolutely harmless are untenable and may cause many sad results among workmen by rendering them careless in taking proper precautionary measures while working with it. Many consider its inhalation harmless under ordinary ventilation. We take exception to that supposition. Most of our inhalation clinical cases result from its toxicity under what are considered by the workmen ordinary conditions. While ventilation will diminish the intensity of the toxicity, the inhalation will not be rendered absolutely harmless thereby. Not ordinary ventilation, but the very best obtainable is required for workers using wood alcohol. At least three times the ordinary air-space allotted per person should be allowed to each workman using it. Placards warning of the poisonous properties of wood alcohol should be posted in conspicuous places about premises where it is used, and hours of labor should be so arranged as to allow for exercise in the open air at frequent intervals. In our subacute cases while the exposure to the vapor for an hour or two daily had not much apparent untoward effect at the time, it certainly did have an effect which manifested itself later by subsequent weakness, trembling and unsteady gait in the intervals between exposures. We are inclined to agree with M. L. Poincaré, who found, after exposing animals to small quantities of vapor of methyl alcohol over a period of from eight to sixteen months, that considerable fatty degeneration of tissues occurred, especially in the liver, heart, muscle, epithelial cells of the uriniferous tubules, some cells of the lungs, and with congestion and slight inflammation of the meninges, and of some nerve centers. He concluded that the vapor of methyl alcohol in small quantities was dangerous.

"Physicians often fail to recognize industrial and occupational diseases because of the fact that they are often masked under the form of chronic disorders, which show themselves in obscure diseases of the digestive tract and nervous system, and are attributed by patients to other causes. A number of cases of methyl alcohol poisoning, to our knowledge, have occurred in which the causes of death were given as pneumonia, meningitis, heart disease, etc. Many of the milder cases have been treated for chronic gastritis, hepatitis, etc. It is not surprising that these unfortunate persons travel from one physician to another searching for relief, when we consider the unfortunate but sad truth that many physicians fail to grasp the true etiology of the cases.

"That a difference in susceptibility to methyl alcohol exists in animals and man cannot be denied, and this can be partly explained by the rate of oxidation which takes place in the animal or person. Those in which it is rapidly oxidized experience the least effect, while those with slow oxidation feel the greater toxic effect. Harnack concluded that methyl alcohol in slow oxidation formed formic acid, while in rapid oxidation carbon dioxid and water were formed. Hence when it is rapidly oxidized, it is comparatively (?) harmless, while in slow oxidation, which usually occurs in man, it is exceedingly toxic, as the action of the formic acid thus produced in the animal organism was much stronger than that of the pure formic acid introduced into the body, as in the latter case the organism attempts to convert it with bases and thus gives rise to formates."

"The laws relating to methyl alcohol should be enforced with a jail sentence as a penalty attached. Until the gravity of the situation is realized by our law makers and the judges in our courts, a certain number of manufacturers who value human life cheaply will continue to be a menace to society by disregarding the law and thus causing blindness and death."

Congress of the National Council for Industrial Safety.

As the JOURNAL goes to press the Third Annual Safety Congress of the National Council for Industrial Safety is being held at the La Salle Hotel in Chicago. About 2,200 representatives of the council in various parts of the country have received personal invitations to attend and interested visitors are also welcomed. An interesting program is prepared but appeared too late to receive notice in the September JOURNAL. The congress opens on the 13th and closes on the 15th and will include, in addition to business meetings and committee reports, special sessions devoted to government, economics, industrial hygiene, transportation and public service, and for manufacturers. Round tables will be held on methods of inspection and on methods of educating workmen in accident prevention. Moving pictures on subjects related to the work will be presented from five to six each afternoon.

To Protect Laundry Workers.

"The Wisconsin Industrial Commission is doing work for accident prevention which is unique in this country, and which is as valuable as it is unique. Under the terms of the law creating it, the commission was empowered to make investigation as to what places are not safe, and to prescribe such safeguards and issue such orders as will make them safe. It was declared to be the duty of the commission to fix standards of safety and to formulate rules and regulations relative to the enforcement of such standards, which rules must be published for the use of all citizens who might be interested.

"One of the early acts of the commission was to appoint a committee on safety and sanitation, which included among its members representatives of employers and labor interests, as well as safety men and the assistant to the commission, Mr. C. W. Price. Besides setting standards for general protection, the committee has taken up special lines, such as elevators and laundries, and, in considering these special lines, it has called into consultation men who have had long experience in them and have devoted much attention to the matter of safety in connection with them.

"In adopting this plan, the commission has been the first state organization in this country to follow the excellent English ex-

ample of calling upon employers and workers to aid in fixing safety standards and formulating safety regulations. Such a plan is most likely to result in the drafting of standards which will be based on experience and will have a really practical value.

"The laundry orders, which went into effect some months ago under the two headings of 'Safety' and 'Sanitation,' deal with the special needs of laundries. Requirements regarding belts, pulleys, gears, set-screws, passage-ways, platforms, stairways, shafting, sprockets, and other points common to industries in general, are covered by general orders of the commission, issued at an earlier date."—*Safety Engineering*, September.

Personal Element in Safety Work.

"Accident-prevention work requires more diplomacy and tact than most people realize as it really resolves itself into a problem of changing men's minds. A man may make a valuable inspector in ferretting out dangerous conditions and devising ingenious safeguards to remedy such conditions, but at the same time not possess the necessary tact and skill in "teaching an old dog new tricks." After all dangerous mechanisms, such as gears, set screws, belts and pulleys have been guarded, it will be found that preventable accidents occurring through the carelessness of the employee will not be overcome to any great extent. The elimination of this class of accidents depends largely on the personality of the safety inspector, or those having the work in charge, in gaining the confidence and good will of the employees, and thereby obtaining the proper coöperative spirit.

"It is conceded generally that the older employees resent the safety idea more than the younger men, and it is only natural that this be true. After a man has operated a machine for a number of years without sustaining an injury, he naturally would feel as though it was a reflection on his ability to have safeguards applied. This condition is particularly found in small shops, and it requires some tact in approaching the employee and gaining the desired confidence. After such an employee is once won over to the side of safety, he will usually prove a very ardent 'booster,' not only in preventing accidents, but in pointing out dangerous conditions. A spirit of coercion should always be assumed in preference to one of aggression, because the latter may have a tendency to arouse a spirit of hostility that will be impossible to overcome. It is far better for the patient to take the medicine from the standpoint of desire than that of compulsion.

"After convincing the operator that a guard should be installed, let him suggest the features of its design, and it is assured that he will feel more friendly toward its use and necessity. Everyone likes to see his own ideas perfected, and the operator, using the machine day after day, is usually acquainted with details that others are not. Such a procedure may require a longer period to perfect a safety organization, but in the end it will enlist 'boosters for safety' that will prove valuable links of the organization.

"An inspector should never assume a spirit of superiority among workmen, but rather one of equality and friendliness. By intimate contact with men, many dangers and hazards may be learned which otherwise would be passed unnoticed. As some one has aptly said: 'Get the men with you and the accidents will take care of themselves.'

"The aggressive spirit that tends toward hostility is perhaps more noticeable among state inspectors than those engaged in other branches of safety work, and the hostile feeling that is often aroused is due to the personality of the inspector and the method pursued. Very few states are accomplishing through their factory inspection departments the results that are possible, which is due mainly to the inspectors not entering into the spirit of coöperation and education, but, instead, looking at it from the angle of the law, and backed by legal authority. A manufacturer will enter into the spirit of the work with greater ardor if he is made to feel as though he were doing it because of right, and the saving derived because of better working conditions than from the feeling as though he were doing it because of external expressure. Unless inspectors are appointed that have the per-

sonality, and can win the confidence of both employer and employee, it is safe to say that accidents will not be reduced in the measure that the importance of the work deserves."—*Safety Engineering*, September.

The Industrial Drinking Water Problem.

The *Engineering Magazine* for September contains a short article on an economical solution of the industrial drinking water problem. In many factories no more provision for drinking water is made than what may be obtained from the tap or from a tank containing ice. In the summer the water from the tap is warm and unpalatable and there is constant danger of the possibility of disease from drinking dirty ice water. Therefore the following clipping seems to be a logical solution of the problem.

"Increased efficiency, larger production, health and satisfaction of employees, and reduction in time lost by them from productive work, all are secured when a bountiful supply of pure water is furnished workers. This is a thoroughly appreciated fact to managers of progressive plants and today the drinking water problem is a live issue in every industrial establishment.

"Various plans have been tried to secure a convenient, adequate supply of pure drinking water of the right temperature at a reasonable cost, but taking into consideration not only the initial investment but the expense of operation, most of them, such as stationary coolers, pipe lines without artificial cooling, stationary drinking fountains with water supply cooled by separate ice boxes, etc., have—as so many managers know to their sorrow—proved both expensive and inadequate and failed to meet the requirements of an ideal drinking water system

"This problem has been solved with remarkable success by the installation of a small refrigerating plant, water cooling tank, and insulated distributing lines with drinking fountains located at convenient points,—solved too at a total outlay of less than the operating cost for two years with the old bucket-and-dipper method. The new method applied in a steel mill in Pittsburgh has reduced the operating cost for supplying drinking water, including cost of the water, to about $1.82 per employee per year, from approximately $5.00 per man by the old method.

The success of such a circulating system, however, hinges upon the insulation of the cooling tank and distributing lines, and too much attention can hardly be paid to the question of securing insulation of proper character and thickness."

Fire Hazards in Cleveland Lodging-Houses.

"The elimination of fire hazards in laborers' lodging-houses in Cleveland has been determined upon by Director of Public Safety Alfred Benesch. He found conditions of great danger—for example, the only egress from a bunk-house room in which nearly 200 men were sleeping was a curving stairway two feet wide.

"The director has started a campaign to do away with narrow and closed winding stairways, to have red lights displayed at all turns leading to fire-escapes, to secure the installation of fire-proof doors and concrete stairs wherever practical, to remove bars from windows leading to fire escapes, to have all main exit doors hung outward and to replace inflammable partitions by ones of corrugated iron.—*Survey*, August 22, 1914.

Compensation for Occupational Diseases.

In the *Public Health Reports* for August 21 is printed a review of a recent law enacted by the Province of Ontario, Canada, which supplements the provision for compensation of industrial accidents by regulations for compensation for occupational diseases.

"There would seem to be no good reason why a workman should not be compensated for physical injury produced by disease caused by his employment as well as for injuries due to accidents. In this connection the law enacted by the Province of Ontario, Canada, May 1, 1914 (4 Geo. V, chap. 25), is of interest for the reason that it not only provides for compensation in case of accidents but makes specific provision for compensation for industrial or occupational

disease contracted in the course of the workman's employment.

"The following are the sections of the act referring to this subject:

"100. (1) Where a workman suffers from an industrial disease and is thereby disabled from earning full wages at the work at which he was employed or his death is caused by an industrial disease and the disease is due to the nature of any employment in which he was engaged at any time within twelve months previous to the date of his disablement; whether under one or more employments, the workman or his dependants shall be entitled to compensation as if the disease were a personal injury by accident, and the disablement were the happening of the accident, subject to the modifications hereinafter mentioned, unless at the time of entering into the employment he had willfully and falsely represented himself in writing as not having previously suffered from the disease.

"(2) Where the compensation is payable by an employer individually it shall be payable by the employer who last employed the workman during such twelve months in the employment to the nature of which the disease was due.

"(3) The workman or his dependants if so required shall furnish the employer mentioned in the next preceding subsection with such information as to the names and addresses of all the other employers by whom he was employed in the employment to the nature of which the disease was due during such twelve months as such workman or his dependants may possess; and if such information is not furnished or is not sufficient to enable that employer to take the proceedings mentioned in subsection 4; that employer upon proving that the disease was not contracted while the workman was in his employment shall not be liable to compensation.

"(4) If that employer alleges that the disease was in fact contracted while the workman was in the employment of some other employer, he may bring such employer before the board; and if the allegation is proved, that other employer shall be the employer by whom the compensation shall be paid.

"(5) If the disease is of such a nature as to be contracted by a gradual process, any other employers who during such twelve months employed the workman in the employment to the nature of which the disease was due shall be liable to make to the employer by whom the compensation is payable such contributions as the board may determine to be just.

"(6) The amount of the compensation shall be fixed with reference to the earnings of the workman under the employer by whom the compensation is payable and the notice provided for by section 20 shall be given to the employer who last employed the workman during such twelve months in the employment to the nature of which the disease was due and the notice may be given notwithstanding that the workman has voluntarily left the employment.

"(7) If the workman at or immediately before the date of the disablement was employed in any process mentioned in the second column of schedule 3 and the disease contracted is the disease in the first column of the schedule set opposite to the description of the process the disease shall be deemed to have been due to the nature of that employment unless the contrary is proved.

"(8) Nothing in this section shall affect the right of a workman to compensation in respect of a disease to which this section does not apply if the disease is the result of an injury in respect of which he is entitled to compensation under this part."

Industrial Respirators.

In the September issue of the *Engineering Magazine* is an instructive article by Sir Henry Cunynghame, on Industrial Respirators, particularly to be used where compressed air is available.

"Among the problems which confront those who are engaged in promoting the health of men engaged in industrial pursuits, none presents greater difficulty than the question of respirators. The inhalation of certain dusts induces a fibroid condition of the lungs, and this is believed to predispose the subject to tuberculosis, but although finely pulverized silica, such as comes from sandstone, is certainly a dangerous dust, we do not know why this is so, nor why other

dusts—such as, for example, plaster-of-Paris and hydraulic cement dusts—should apparently be innocuous. Investigations are at present in progress for the purpose of trying to ascertain whether it is the sharp angularity of the quartz which bestows on silica dust its deadly character, but our knowledge on this point up to the present time is very meagre.

"The principal means of combating the dangers of dust now in use are: (1) fans for removing it; (2) the use of water to prevent it from rising or to lay it after it has risen; and (3) respirators.

"At first sight it might seem that a man provided with an efficient respirator would be perfectly safe, even if surrounded by dust. This is true; but, unfortunately, if the respirators are efficient they not only keep out the dust, but also become so intolerably hot, and interfere so completely with respiration that it is impossible to wear them in practice. So far no one has yet designed a simple form of respirator that is at the same time efficient."

The author designed a respirator on the same principle as that used for diving dresses and firemen's helmets. The respirator is of conical form which enables it to be moulded to fit any face and is held in place by two straps passing over the head in such a way that the cone may easily be removed for expectorating, etc. An inlet pipe for air keeps up a steady stream of air which issues from the pointed nozzle and tends to blow dust away from the face. An interior cone serves to break the force of the entering air, and prevent it from impinging in a cold stream directly on the mouth and nose.

Recent Publications.

Among some of the bulletins and pamphlets which have come to our notice, the following may be of value to persons interested in generals topics of industrial hygiene and safety:

The United States Department of Labor, Bureau of Statistics, has recently published under the head of Bulletin 142, the results of an investigation made of the methods of "Administration of Labor Laws and Factory Inspection in Certain European Countries." The investigation covered Great Britain, Germany, France, Austria, Belgium, and Switzerland.

The conclusions drawn from the investigation are quoted in part below:

"Is there anything special in the theory or practice of factory inspection abroad, either in the form of organization, or in the specialization of functions, or in the standards set for safety and sanitation, or in the methods of inspection, that is new, specially distinctive, or much superior to the practices among the factory inspection departments in the United States? The author does not believe there is.

"In some of our best organized factory inspection departments in several states we find a form of organization and a functional specialization that is certainly not behind the best examples of European inspection departments. Indeed, some of our new industrial commissions have certain points of superiority over European practices. We also find factory inspection departments in some states that have of late years made a serious attempt to adopt scientific standards and have resorted to expert industrial advice, and to trade and industrial conferences, methods which are destined to equal, if not surpass, the practices and methods used in other countries.

"Wherein, then, is the superiority of European inspection over that of the United States, if there is such superiority?

"The author's opinion is that such superiority does exist, but it exists only in 'the higher grade and character of the inspectorial force.'

"In this respect Europe is far in advance of the United States. We have no such inspectors as a class. Here and there, in one state and another, there may be found one or more excellent examples of efficient trained factory inspectors; but these are isolated cases. The rank and file of European inspectors are far above the rank and file of our own inspectors.

"The reasons for this anomalous situation are found in the body of the report as well as in the introduction. They may be summed up as follows: (1) factory inspection in Europe is a profession, a vocation, and is regarded as a life work; (2) factory inspect-

ors in Europe must go through a long preliminary preparation, must have a scientific education and technical training; (3) merit, length of service, and competence are the only cases for promotion from one grade to another; (4) superiors, chiefs, and heads of the service are promoted from the ranks only for merit, experience, length of service, and competence; (5) the tenure of office is secure, promotion certain, treatment liberal, and a pension is given for long service and old age."

Another bulletin (152) issued by the same department is a Summary of Decisions of Courts and Opinions Affecting Labor in 1913.

"The material distributes itself naturally under two general heads: opinions of the attorney-general and court decisions, the latter being presented under the subdivisions, decisions under statute law, and decisions under common law. The question of the application of the recent eight-hour legislation by Congress affords the only subject for consideration by the attorney-general here noted. Among court decisions, workmen's compensation decisions are perhaps of first rank, both in numbers and interest. The Federal statute relative to the liability of railroad companies engaged in interstate traffic for injuries to their employees afforded the basis for much litigation, and a number of cases were carried to the circuit courts of appeals and to the Supreme Court. A point of particular interest involved in these cases is as to the boundaries to be set to the law in its inclusion or exclusion of certain classes of employees."

The New York State Department of Labor has recently issued their annual report for 1913. This is a very complete report of the different lines of work carried on by the department, including a report of the commissioner, a report of the Bureau of Inspection, report of Bureau of Mediation and Arbitration, and Bureau of Industries and Immigration. There is also a summary of the state labor laws, the workingmen's compensation law, 1913, and opinions of the attorney-general concerning labor laws.

The Industrial Board of the New York State Department of Labor, during the past summer, issued a pamphlet concerning the proposed rules defining fire-proof and fire-resisting materials and describing certain specifications relating to construction. Since these rules apply particularly to the construction of industrial buildings they may be instructive for those interested in this subject.

A bulletin recently issued by the Children's Bureau of the United States Department of Labor concerning laws relating to "Mother's Pensions" in the United States, Denmark, and New Zealand, is instructive in that it presents in concise form the latest ideas and laws on this subject. Miss Julia C. Lothrop, chief of the Bureau, says in part concerning the report:

"The methods and standards prescribed in the different states vary. It is impossible that all should prove equally valuable in serving their common purpose. At the present time it is impracticable for this bureau to undertake any field study of the operation of these laws (even were it not premature,) but in view of the immediate legislative importance of the matter of its various bearings it is believed that the compilation of American texts, together with the New Zealand law passed in 1911 and a translation of the Danish law passed in 1913, added for purposes of comparison, will prove timely and useful. The bibliography, while not exhaustive, contains most of the significant recent material."

CURRENT PUBLIC HEALTH LITERATURE.

AMERICAN.

American Journal of Medical Sciences.

CXLVIII, No. 2. August.

Smegma Bacillus. G. E. Breeton and K. W. Smith.

Archives of Pediatrics, New York.

XXXI, No. 8. August.

Etiology of Whooping Cough. A. W. Williams.
Clinical and Sociological Aspects of Whooping Cough. J. L. Morse.

Engineering Record, New York.

LXX, No. 8. August 22.

Water Discharge Measurement with Chemicals. Pt. 1. B. F. Groat.
Economic Aspects of Intermittent Sand Filters.
"Clean Up Week" in Philadelphia.

IX. August 29.

Water Discharge Measurements with Chemicals. Pt. 2. B. F. Groat.
Growth of Chicago Sanitary Bureau.

X. September 5.

Revamped Waterworks and New Purification Plant at Fort Smith, Arkansas.
Economical Depth of Covered Reservoirs. F. H. Carter.
Water Purification Plant at Flint.

XI. September 12.

Report on Electrolytic Sewage Treatment at Elmhurst. P. M. Travis.
Sanitation in Labor Camps.

Journal—Lancet.

XXXIV. No. 14. July 15.

Relation of Sanitation to Death and Disease. H. W. Hill.

Journal of Outdoor Life, New York.

XI. No. 8. August.

Problem of Infection in Tuberculous Families. J. B. Hawes.

Journal of the American Medical Association, Chicago.

LXIII, No. 9. August 29.

Twelfth Annual Summary of Fourth of July Injuries.
Plumbing and Health. Editorial.

X. September 5.

Active Immunization in Diphtheria and Treatment by Toxin-Antitoxin. W. H. Park and A. Zingher.
The Use of Antitoxin in Diphtheria. S. S. Woody.

No. 11. September 12.

Focal Infection. F. Billings.
The Newer Bacteriology of Various Infections as Determined by Special Technic. E. C. Rosenow.
Experimental Researches in Methyl Alcohol Inhalation. H. H. Tyson and M. J. Schoenberg.
The Bacteriology of Typhus Fever. R. M. Wilder.

Military Surgeon, Chicago.

XXXV, No. 2. August.

Sanitary Service of Maneuver Camps. J. H. Ford.
Investigation Relative to Life Cycle, Breeding and Some Practical Means of Reducing the Multiplication of Flies in Camp. H. C. Michie.

Oklahoma State Medical Association Journal, Muskogee.

VII, No. 3. August.

Relationship of Nervous Diseases to Venereal Diseases. J. W. Duke.
State Health Problems. J. C. Maher.

Public Health Reports.

XXIX, No. 35. August 29.

Plague in New Orleans.

XXXVI. September 4.

Plague in the United States.
The Making of Health Officers—The Possibilities of State Departments of Health Improving the Efficiency of Local Health Officers by Means of Correspondence Courses in Health Administration and Allied Subjects.
Mosquitoes and Malaria—Report on a Short Trip in Eastern North Carolina.
Plague Eradicative Work.

XXXVII. September 11.

Plague Eradicative Work.
Certificates of Health before Marriage—Wisconsin Marriage Law Held Valid by a Divided Court.
The Hygiene of Rural Schools.

XXXVIII. September 18.

Plague Eradicative Work.
Trachoma—A Survey of Its Prevalence in the Mountain Sections of East Tennessee and Northern Georgia.
Tuberculosis—The Financial Aspect of the Sick Leaving Home in Search of a Beneficial Climate.

FOREIGN.

British Medical Journal, London.

2797. August 8.

The Responsibility of the State in Connection with Venereal Disease. A. K. Chalmers.

Public Measures against Venereal Disease in Denmark. E. Pontoppidan and L. McIlroy.

Essential Preventives of Prostitution. L. Grant.

Journal of State Medicine, London.

XXII. August 8.

Germ Carriers. L. Vaillard.
Rise and Progress of Factory Legislation. T. Oliver.

Monatschrift fur Kinderheilkjunde, Leipzig.

XIII, No. 8. July.

Dissemination of Scarlet Fever by Fomites. R. Weigert.